SNR EXHIBIT 1

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

IN RE: INTEREST RATE SWAPS ANTITRUST LITIGATION	)	Consolidated No. 16 MD 2704 (PAE)

REVISED EXPERT REPORT OF MARK GRINBLATT, Ph.D.
APRIL 2, 2019

SUBJECT TO PROTECTIVE ORDER – PRIVILEGED AND HIGHLY CONFIDENTIAL

EXPERT REPORT OF DR. MARK GRINBLATT

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I. INTRODUCTION AND SUMMARY OF CONCLUSIONS

A. Background and Qualifications

1. I hold the title of Distinguished Research Professor at the University of California, Los Angeles (UCLA) Anderson School of Management. I obtained a Ph.D. in economics from Yale University, and was awarded an honorary doctorate in economics from Aalto University in Helsinki Finland. I joined the UCLA Anderson School faculty in 1981, where I taught finance for nearly 40 years, earning tenure in 1987. Over the course of my career there, I have held the J. Clayburn LaForce Endowed Chair in Management, the Japan Alumni Chair in International Finance, and was named Distinguished Professor in 2016.

2. From 2005 through 2008, I supervised the Ph.D. program in finance at the Anderson School. From 2008 to 2013, I served as Senior Associate Dean and Director of the entire Ph.D. program—overseeing doctoral studies in all areas of the School. I am also well known as a research supervisor of top Ph.D. students, many of whom are now well regarded professors at major universities.

3. I serve or have served as the advisory editor to two academic journals, as associate editor of four scholarly journals, and as a member of both the executive committee and board of directors of the National Bureau of Economic Research (NBER). Most of the journals and the NBER represent the elite venues for scholarly research in the fields of economics and finance.

4. My academic expertise is broad, focusing on both the theoretical and empirical aspects of various topics in economics and finance, including asset pricing, derivatives (such as interest rate swaps or "IRS," currency swaps, and Eurodollar futures), market microstructure, institutional trading profits, asymmetric information, security design, fixed income securities, liquidity, trading behavior of institutions and households, analyst forecasts, financial services industry incentives, hedging instruments, statistics and empirical methodologies, and behavioral economics. My research publications have been widely cited and include more than 50 research papers, books, and articles, most of which appear in the top publication outlets in my field.

5. A portion of my academic research and business careers have revolved around IRS. While on a leave of absence from UCLA in 1989 and 1990, I worked as a Vice President for arbitrage support at Salomon Brothers, Inc., the largest IRS dealer at the time. I subsequently co-authored a textbook on the general principles of finance, titled *Financial Markets and Corporate Strategy*, which discusses IRS. I am also one of the first academics to publish on the topic of the

valuation of IRS, in an article titled "An Analytic Solution for Interest Rate Swap Spreads," published in 2001 in the peer-reviewed journal *International Review of Finance*. I have published papers on currency swaps, and several other fixed income securities, like Treasury Strips, LIBOR and Eurodollar futures. I have testified in court on a matter involving interdealer brokers ("IDBs") and served on the board and audit committees of a major IRS intermediary (Citi Swapco, Inc.), which at times had more than a half trillion dollars in outstanding IRS notional.

6. I have been awarded several prizes and honorific rankings for my scientific research. I was named among the 75 most prolific authors in elite journals over the first 50 years of finance research. I earned best paper prizes from IQ-KAP, Federal Association of Alternative Investments, and the Asia Asset Management CFA Institute. My research was also awarded a Smith-Breeden distinguished paper prize, the Anbar Citation of Excellence, and prizes from Goldman Sachs, Hillcrest, and the Q-group. I have been a fellow at several notable places, including the Securities and Exchange Commission, Yale University's International Center for Finance, the University of Washington, the WU Guttman Center of the Vienna Graduate School, and Hong Kong Polytechnic Institute. I frequently present my scientific research at scholarly colloquia, conferences, and panel discussions. This includes several occasions as a keynote speaker at major conferences, including one that most recently was watched by approximately 200,000 viewers.

7. I previously held the posts of Vice President, Program Chairman, and President of the Western Finance Association. I served as a director on the board of the American Finance Association from 2005 through 2008 and was twice elected to the board of the Foundation for the Advancement of Research in Financial Economics, serving from 2011-2017. Before joining its board, I was also elected as a Research Associate of the National Bureau of Economic Research. I have been asked to nominate candidates for the Nobel Prize in Economic Sciences, for the distinguished Onassis Award in Trade, Shipping, and Finance, the Carlo Alberto Medal, and for the Deutsche Bank Prize, among others.

8. In addition to my academic work, I have extensive consulting and practical experience in the financial services industry. For almost a quarter century, and as noted above, I served on the board of directors and board audit committee of Citi Swapco, Inc., an affiliate of Citigroup, Inc. that intermediates over-the-counter ("OTC") derivative transactions between external counterparties, largely IRS. In addition to providing arbitrage support at Salomon

Brothers, I have also been a principal of a hedge fund.

9. My qualifications are provided in detail in the curriculum vitae attached as Appendix 1. Appendix 1 also contains a listing of my expert testimony for the past five years. My expert assignments, both with and without testimony, have included retentions by several of the Defendants in this matter or their affiliated companies. Appendix 2 contains a listing of the materials that I have relied upon in reaching the conclusions in my report.

B. Scope of Assignment

10. Class Plaintiffs allege that, both during and before the class period,[1] Defendants conspired to prevent the emergence of anonymous all-to-all IRS trading platforms,[2] including a boycott of swap execution facilities ("SEFs") such as Javelin, TeraExchange, trueEX and Bloomberg.[3] Plaintiffs also allege that Defendants collectively prevented IDBs such as ICAP and Tradition from offering anonymous all-to-all platforms, including by insisting that those IDBs maintain or adopt a trading protocol known as "post-trade name-give up."

11. I have been asked by Class Plaintiffs' counsel to analyze and opine on the following issues, assuming the conspiracy alleged:

- Whether, from an economic perspective, Defendants' alleged conspiracy impacted all or nearly all class members; and
- Whether an existing methodology that is grounded in accepted principles can reliably compute the damages caused by the alleged conspiracy using a formulaic approach that can be applied on a class-wide basis.

For the reasons discussed in this report, my opinion as to both questions is that the answer is:

yes.

C. Summary of Conclusions

12. The Class Plaintiffs in this case allege that Defendants conspired to prevent a

[1] I have been advised by counsel that the class period commences on January 1, 2013. My use of the term "class period" pertains to the time period January 1, 2013 to present (or to any other end date determined by the fact-finder or Court).

[2] I use the term anonymous all-to-all platforms to mean trading platforms with either an anonymous central limit order book ("CLOB") trading protocol or an anonymous Request-for-Quote ("RFQ") or "blast" type all-to-all trading protocol.

[3] The Defendants in this matter are identified in the Third Consolidated Amended Class Action Complaint ("TAC"), Dkt. 398 in No. 16-MD-2704.

certain type of market structure from emerging in the IRS market: anonymous all-to-all trading. Both as an economist and as a testifying expert, I have conducted numerous analyses of various financial markets, including equity markets around the world, fixed income markets, and derivatives markets. In conducting such analyses, I routinely have to consider and evaluate the impact of market structure on the prices paid and received by market participants. Evaluations of shifts in market structure are invariably, with limited exceptions, common to all or nearly all market participants. That is, the fundamental conclusions and methodology do not differ based on the type of market participant (*e.g.*, hedge vs. endowment vs. or pension fund, small or large participant, tax exempt participant or not) or the participant's trading strategy.

13. Based on my experience as an economist and expert, such analyses are, by definition, market-centric, not investor-centric—*i.e.*, they focus on the impact market structure has on all the investors in a market. When evaluating the impact of changes in fundamental market structure, economists often rely on market-centric sources such as transaction data, analyst reports and studies of market structure, theoretical and empirical research literature, and the opinions and testimony of market participants. These are the types of sources I relied on in preparing my report.

14. Based on my extensive background in the fields of economics, finance, and IRS, my experience in the financial sector, and my review of various materials relating to this matter, including the Report of Professor Darrell Duffie, it is my opinion that by preventing IRS from evolving to an all-to-all market structure, the alleged conspiracy: (i) negatively impacted all members of the proposed class; and (ii) harmed each class member financially to a degree that is demonstrable and quantifiable from common evidence and a formulaic methodology that can calculate the damage across all class members.

15. These conclusions flow from the way the alleged conspiracy would have maintained higher spreads on IRS transactions than would have existed had Defendants not conspired to prevent the IRS market from moving to an anonymous all-to-all market structure. Higher spreads financially harmed class members by causing them to pay higher, or receive lower, prices on IRS transactions with Defendants than they would have paid or received if there had been no alleged conspiracy. There are several reasons why the negative impact of the alleged conspiracy in IRS trading was market-wide.

16. *First*, many IRS instruments—including traditional fixed-floating IRS, overnight index swaps ("OIS"), forward rate agreements ("FRAs"), and basis swaps included in the class

definition—would have traded with greater transparency in the but for world, at prices associated with greater competition from liquidity providers. This would have resulted in lower bid-ask spreads for class members. As Section IV discusses, spread compression for these instruments would be substantial, and at least, conservatively measured, within the range of approximately 80%, as indicated by: (i) empirical "real world" evidence from the migration of other instruments—including Treasury securities, dividend swaps, futures contracts, options, corporate bonds, and equities—from bilateral to competitive market structures; (ii) the economic characteristics of IRS, which indicate they will transact at very low spreads in a competitive, transparent market for liquidity provision; and (iii) my analysis of the spread compression already experienced by IRS instruments under the limited changes to market structure implemented under Dodd-Frank mandates. This conclusion also finds support and further confirmation in Defendants' own contemporaneous documents, which predicted bid-ask spread compression between [redacted]% and [redacted]% should anonymous all-to-all trading occur.

17. *Second*, spread compression is an economic benefit that would have been experienced by all types of investors represented in the class, including corporate treasury, pension funds, insurance funds, endowment funds, or hedge funds, and would not be specific to any particular reason for trading IRS. The IRS product-types included in Plaintiffs' proposed class definition, irrespective of trade size, would experience spread compression due to the introduction of anonymous all-to-all trading platforms because of the additional transparency and competition delivered to the market as a whole by such platforms, even though relative levels of spread compression could differ based on product type, trade size, or year of trade. Importantly, even class members who might have perceived a relative benefit over other class members from over-the-counter ("OTC") trading would experience (absolute) lower spreads in the absence of the conspiracy alleged.

18. *Third*, to determine whether investors would have been harmed by the alleged conspiracy, it is not necessary to make individual determinations about how investors would have traded the four different types of at-issue IRS products absent the conspiracy. Even if an IRS product was not suitable for trading directly on an anonymous all-to-all platform, the existence of such platforms and their price competition and transparency would still have improved the pricing for such products in transactions not undertaken on such platform. In Section V of my report, I set forth a conservative methodology for calculating such spread compression. My analysis is

conservative because I apply a lower spread compression rate for any product that was not both cleared and SEF-traded during the class period, even though many such products very likely would have directly traded on anonymous all-to-all platforms (and thus received even greater spread compression) in the but for world or been "substituted." Substitution means that class members would have been increasingly incentivized to substitute highly standardized products suitable for anonymous all-to-all trading for relatively less standardized products because of the benefits of doing so, including superior execution and lower spreads.

19. *Fourth*, by increasing spreads and thus the cost of trading IRS products, the alleged conspiracy reduced trading *volumes* in virtually all IRS products (and overall) relative to the trading volumes that would have prevailed absent the conspiracy. One consequence of this volume reduction is fewer desirable trading options and less liquidity (and thus immediacy) in the IRS market. The resulting dearth of attractive trades itself harmed members of the class. By contrast, anonymous all-to-all trading and its lower spreads would have generated a larger number of transactions in each of these products, raising the number of desirable trading options available to class members, while also permitting the class to act and profit as liquidity providers (and not just takers).

20. Based on my analysis and my extensive expertise, I developed a methodology that reliably, albeit conservatively, calculates the increased spreads paid and associated damages across class members on their IRS transactions throughout the class period.

21. My class-wide, formulaic methodology allows for the quantification of the but for world's spread compression both for the proposed class as a whole and for each individual class members' trades. This methodology can be employed for any class member, regardless of their participant-type, size, the volume or types of IRS they traded, or their trading strategy. I set forth this methodology in Section V.

22. My damages analysis uses what I previously referred to as a "but for" world, *i.e.*, the structure and operation of the IRS market in the absence of the conspiracy alleged. While I reach my own opinions and conclusion about the nature of the "but for" world, my views are consistent with, and at times informed by, those expressed by Professor Darrell Duffie in his expert report.

II. INTEREST RATE SWAPS

23. The purpose of this section is to provide an overview of the subset of IRS that I

have been asked by counsel to focus upon in this report and that are included within the class definition: traditional fixed-floating IRS, OIS, FRAs, and single-currency basis swaps. I begin this section by describing these specific categories of IRS. These specific IRS instruments are related to a clearly delineated subset of IRS transactions and do not include more complicated forms of IRS such as, among other things, swaptions, "caps" and "floors" and cross currency swaps. Much of the trading volume in these categories accordingly involved standardized IRS well-suited to trading on anonymous all-to-all platforms. To provide context for such instruments, I discuss certain objective criteria that can be used to evaluate which IRS transactions were suitable for trading on an anonymous all-to-all platform. Finally, I describe the services provided by the dealer Defendants in IRS transactions,[4] and the markup they charge, a term coined earlier in my report and commonly referred to in the industry as the "bid-ask spread." As I explain, to the extent that the dealers overcharged bid-ask spreads on these IRS, the overcharge would affect all IRS in a similar way. My discussion of dealership and IRS bid-ask spreads is applicable to all four of the specific types of more "plain vanilla" and more standardized IRS product types discussed in this section.

A. IRS Affected by Defendants' Conspiracy

24. IRS are agreements between two counterparties to exchange one stream of interest payments for another, with each stream computed by applying a designated interest rate to a contract size referred to as the swap's "notional amount."[5] The exchange takes place at a frequency and over a period of time that is specified in the swap contract, which is usually tied to a master contract containing common terms and definitions.[6] IRS contracts can take different forms depending on the timing and ultimate horizon (or "tenor") of their stipulated payments, the underlying interest rates that determine the direction and magnitude of the payments, and the currencies used for payment. The tenor of the swap, generally measured as the difference between

[4] Although my damages analysis focuses on the four types of IRS products referred to above, the methodology I employ does not depend on the inclusion of all or only some of these categories. My damage estimates could be adjusted to remove any of these categories or incorporate others if evidence or other legal rulings change the scope of the interest rate derivative products covered by this action.

[5] *See* Mark Grinblatt and Sheridan Titman, *Financial Markets and Corporate Strategy* (McGraw-Hill/Irwin, 2nd edition, 2002), pp. 221-222.

[6] *See* ISDA 2002 Master Agreement and the 2000 and 2006 ISDA Definitions pertaining to interest rate swaps.

the swap's "effective" or start date and the swap's maturity date, represents the length of time over which the swap's periodic payments are exchanged, indeed swapped, by its counterparties.

25. The effective date of an IRS is the date from which stipulated interest payments begin accruing under the contract. When parties agree that the payments begin accruing within two business days of agreement, the swap contracts are called "spot starting."[7] However, the parties may also agree to defer the effective date to a date in the more distant future (*e.g.*, one year from the transaction date).

26. In the sections immediately below I discuss the four major categories of IRS I have been asked to focus on: (1) traditional fixed-floating IRS, in which a negotiated fixed interest rate is exchanged for floating rate payments based on interest rates such as LIBOR and EURIBOR; (2) forward rate agreements (or "FRA"), which can be viewed as a fixed-floating swap with a single future date at which interest payments are exchanged and for which settlement timing for an accrued interest period is at the start of, rather than just after, the interest accrual period; (3) overnight index swaps (or "OIS") that also exchange fixed for floating interest rates but employ very short-term floating rates, such as the overnight Fed Funds rate and the Euro Overnight Index Average (or "EONIA"); and (4) single-currency basis swaps, which exchange one floating rate for another, but with one floating rate adjusted by a fixed, negotiated amount. As described below, each of these product categories include swaps that were centrally cleared, traded electronically, and had common economic specifications that would make the majority of these swaps sufficiently standardized to support all-to-all trading.

27. At the outset, I note that at the instruction of counsel I excluded a number of IRS products from this discussion because they are not included in the proposed class. I have not included swaptions, "caps" and "floors," or cross-currency basis swaps. Instead, at counsel's direction, I have focused on the four categories of IRS products identified at the beginning of this section and that are included in the class definition. My analysis is thus inherently conservative in that I do not attempt to quantify damages for entire categories of IRS products, some of which would have also benefited from the introduction of anonymous all-to-all trading.

28. For illustrative purposes, Tables 1.a and 1.b below provide an overview of the size of the IRS market for the period 2013 through 2017 for each of the four "in-scope" product

[7] For some currencies, such as Pounds Sterling, spot-starting contracts also include "Same Day" starting IRS where the effective date is T+0.

categories. The data I use, which I refer to as "Part 43 data", is based on trade records submitted to two swap data repositories ("SDRs"), Bloomberg and the DTCC Data Repository (U.S.) LLC ("DTCC")[8] under the real-time reporting requirements (also known as "Part 43" requirements) instituted by the Commodities Futures Trading Commission ("CFTC") pursuant to Dodd-Frank legislation. For transactions with notional amounts that are sufficiently large to meet the criteria for a "block" trade, the notional amount reported is capped at sizes specified in the CFTC's regulations,[9] thus understating the full notional traded. The remaining transactions' notional amounts, reported at their full levels, are rounded to the nearest value according to the CFTC's regulations.[10,11]

29. Table 1.a shows that of the approximately [redacted] transactions conducted in IRS from 2013 through 2017, approximately [redacted] (or [redacted]%) were traditional fixed-floating IRS.[12] This category also accounts for the largest reported notional (approximately $[redacted] based on capped notional amounts reported). FRAs accounted for only [redacted] transactions ([redacted]% of the total), but approximately $[redacted] in reported notional [redacted]% of the total). OIS transactions represented the third largest category, while basis swaps accounted for relatively

[8] The publicly available SDR data was retrieved from a Bloomberg terminal using the "SDR Trade Activity" screen.

[9] Specific rules to address Block Sizes of Large Notional Off-Facility Swaps and Block Trades can be accessed from the U.S. Commodity Futures Trading Commission ("CFTC") website https://www.cftc.gov/LawRegulation/DoddFrankAct/Rulemakings/DF_18_RealTimeReporting/index.htm.

[10] The role of SDRs in assembling and disseminating information about IRS transactions is discussed in Data Repositories, U.S. Commodity Futures Trading Commission: U.S. Commodity Futures Trading Commission (CFTC), *Data Repositories*, https://www.cftc.gov/IndustryOversight/DataRepositories/index.htm.

[11] The CFTC established rules for rounding the public dissemination of notional. The rounding rules are specific to the notional amounts transacted. Real-time Public Reporting of Swap Transaction Data, 17 CFR §43.4(g), (2012).

[12] Each of the [redacted] transactions are classified as one of the following transaction types: trade, amendment, novation, termination, trade increase, trade-novation and novation-termination.

minor fractions of both transactions and notional volume.

Table 1.a

IRS Transactions Reported from 2013 - 2017 per Part 43				
Product Category	Transactions	%	Notional (USD) in mm	%
Fixed-Float	[redacted]	[redacted]	[redacted]	[redacted]
FRA	[redacted]	[redacted]	[redacted]	[redacted]
OIS	[redacted]	[redacted]	[redacted]	[redacted]
Basis	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]

Source: Bloomberg's SDR Trade Activity Screen

30. Table 1.b shows that a substantial majority of all reported notional volume in each IRS category was cleared through central clearing counterparties ("CCPs", or clearinghouses). In a centrally cleared transaction, a clearinghouse interposes itself between the two parties in an executed IRS transaction. The clearinghouse becomes the counterparty to each transacting party, shielding each counterparty on the swap from the default risk of the other.

Table 1.b

Percentage of IRS Notional (USD) Cleared per Part 43						
Product Category	Total	2017	2016	2015	2014	2013
Fixed-Float	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
FRA	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
OIS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Basis	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Source: Bloomberg's SDR Trade Activity Screen

31. As this section later discusses, the ability to clear a swap is an indicator of the swap's suitability for trading on an all-to-all platform. CCPs can manage their own risks from counterparty default only if the swap's terms are fairly standardized. Table 1.b shows that by 2017, more than [redacted]% of reported notional volume was cleared in each of the four categories of IRS. The percentages are based on the real-time SDR data described earlier which contains a clearing identifier on the trade record. Table 1.b thus indicates that [redacted] of notional volume in all four product categories was transacted in standardized contracts.[13]

[13] Certain entities are exempt from the clearing mandate established by the CFTC. Accordingly, two swaps may share common economic terms but under the clearing mandate, one entity may be required to submit the swap for

32. Table 1.b includes transactions conducted both between dealers and buy-side clients ("D2C") and between two dealers ("D2D"). However, the high levels of clearing observed in the aggregate data are not merely driven by inter-dealer transactions. IRS transaction data from the two leading trading platforms for dealer-client transactions during the class period show that very high percentages of traded notional volumes were centrally cleared from 2013-2017. For example, the first venue, Bloomberg's SEF, reported that [redacted]% of notional in fixed-floating IRS, [redacted]% of notional in OIS, and [redacted]% of notional in basis swaps were centrally cleared (FRAs were not traded on Bloomberg's SEF during this time period). Transactions on Tradeweb's SEF reported similar percentages for the same period: [redacted]% for fixed-floating IRS, [redacted]% for OIS, and [redacted]% for basis swaps.[14] Thus, virtually all of the notional amount transacted on the major dealer-client venues involved centrally-cleared IRS contracts.

33. Below I provide additional detail on the four major types of IRS encompassed within the class definition.

1. Traditional Fixed-Floating IRS

34. With traditional fixed-floating IRS, periodic payments are exchanged by counterparties based on the difference between a fixed rate that is agreed upon at execution, referred to as the "swap rate," and a specified floating rate governing interest over the payment period. One counterparty to the swap, commonly referred to as the "buyer," receives the floating rate and pays the fixed rate, while the "seller" counterparty pays the floating rate and receives the fixed rate.

35. In most traditional fixed-floating IRS, the agreed-upon swap rate is set at a level that is "fair," meaning that no amount is initially exchanged between the counterparties. Fair swap rates are largely determined by investors' expectations about the path of future short term interest rates. The latter correspond to the floating leg of the swap. Only interest payments are exchanged in a swap, and these payments are always netted in the same currency and at the same date. When

clearing and the other, if exempt from the mandate, may not. Thus, the fact that a swap is not cleared does not mean that the contract features themselves are not sufficiently standardized for clearing. Clearing Requirement Determination Under Section 2(h) of the CEA, 17 C.F.R. § 50.2 (2012).

[14] Tradeweb operated a SEF but also conducted off-SEF transactions. The percentages of notional cleared are based on transactions that Tradeweb identified as on-SEF transactions. All Bloomberg SEF transactions are identified as on-SEF transactions and accordingly, the clearing percentages are based on all Bloomberg SEF transactions. I discuss swap execution facilities in greater detail in Section III of this report and the Bloomberg SEF and Tradeweb data in Appendix 3.

netted, one counterparty receives and the other pays the accrued interest difference at a payment date, but who pays cash to the other depends on a comparison of the swap rate with the prevailing floating rate. Payers and receivers of this cash can switch places as floating rates change over the swap's life.

36. Moreover, with traditional fixed-floating IRS, no final principal is exchanged at maturity, as the fixed and floating swap legs have identical principal that nets out to zero. This is why the principal amount has historically been given the term notional, as it serves only to determine the magnitude of periodic interest payments to each party.[15] The notional amount typically remains constant throughout the life (*i.e.*, tenor) of the swap. The range of tenors for traditional fixed-floating IRS ranges from days to decades.

37. The majority of traditional fixed-floating IRS traded during the class period had common contractual terms that are uniform across investors. These economic terms are largely observable from the Part 43 data and include specifications such as fixed notional amounts denominated in common currencies, common floating rate reference indices, common payment frequencies, common tenors, and common effective dates. I discuss these standard attributes in additional detail in Section II.C.

38. To illustrate the payments implied by common contract terms, consider a $50 million U.S. dollar notional spot starting fixed-floating IRS with a 5-year tenor and U.S. dollar 3-month LIBOR as its floating rate benchmark. In a common contract of this type, the party paying the fixed rate pays interest semiannually on a 30/360 basis while the party paying the floating rate pays the 3-month LIBOR quarterly on an actual/360 basis.[16] Both the swap rate and the floating interest rates are applied to the same $50 million notional amount.

[15] This is true for the other IRS in the class definition as well.

[16] Under a 30/360 basis, interest payments within any payment period are computed under the assumption that each month has exactly 30 days, regardless of the actual number of days within the months spanning this payment period. Under an actual/360 basis, interest payments are computed under the assumption that a year has only 360 days but takes into account the actual number of days within the payment period when determining interest payments due. *See* 2006 ISDA Definitions, pp. 11-12.

39. The semi-annual fixed (swap) rate payment is determined by multiplying one-half of the fixed rate percentage to the notional amount at six month intervals starting six months from the effective date.[17] I refer to these as payment dates.

40. In this example, the floating-rate payments over the same six-month intervals are based on two prior announced resets of the U.S. dollar 3-month LIBOR rate as follows.[18] Assume that 6 months prior to the next fixed-payment date, the newly announced rate on U.S. Dollar 3-month LIBOR was 0.253 percent annually (or 0.06325 percent quarterly) and that 3 months prior to this payment date, the newly announced 3-month LIBOR rate was 0.255 percent annually (0.06375 percent quarterly).[19] Then the floating-leg payments each quarter within this six-month interval would be $31,625 (the 0.06325 percent times the $50 million notional) and $31,875 (equal to 0.06375 percent times the $50 million notional). The floating-rate payment due at the same time as a fixed rate payment is netted against this fixed rate payment. Thus, the fixed rate payments under the swap are based upon the fixed rate negotiated by the parties at the commencement of the swap, but the floating rate payments are based on 20 quarterly resets of the 3-month USD LIBOR rate. These resets commence at the effective date of the IRS and end three months before the swap matures, the date of its last semi-annual payment. Note that with traditional fixed-floating IRS, the exchange of payments takes place only after interest on both the fixed and floating side has accrued.

41. Once the fixed rate (or swap rate) is negotiated on an IRS, one counterparty may experience a gain and the other a loss if interest rates change in the future during the lifetime (or tenor) of the swap. Which counterparty receives the gain depends on the future direction of interest rates over the term of the swap and whether a counterparty is the payer or receiver of the fixed rate. An increase in future interest rates is good for the fixed rate payer (floating rate recipient)

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[17] The convention of multiplying the rate by one-half is based on the 30/360 day-count convention. For details on payment, day count and business day conventions, see 2006 ISDA Definitions, pp. 1, 11-13.

[18] The U.S. dollar 3-month LIBOR rate is announced daily by Intercontinental Exchange ("ICE") at approximately 11:55 a.m. London time. *See* ICE Benchmark Administration, *Libor: Frequently Asked Questions*, https://www.theice.com/publicdocs/IBA_LIBOR_FAQ.pdf. From January 1986 until January 2014, LIBOR was administered by the British Bankers' Association. *See* ICE Benchmark Administration, *Roadmap for ICE LIBOR*, https://www.theice.com/publicdocs/ICE_LIBOR_Roadmap0316.pdf (2016).

[19] The announced 3-month LIBOR rate is an annualized rate. *See* ICE Benchmark Administration, *Libor: Frequently Asked Questions*, https://www.theice.com/publicdocs/IBA_LIBOR_FAQ.pdf. For a standard ISDA contract, the day-count convention for this swap's floating rate leg is typically actual/360. *See* H. Corb, *Interest Rate Swaps and Other Derivatives* (Columbia University Press, 2012), p. 4. This example assumes the actual number of calendar days in each quarterly period was 90.

but bad for the fixed rate recipient (floating rate payer); the converse is true for a decrease in rates. Having locked receipt of a higher rate than the new prevailing fixed rate is good when the latter rate declines. Thus, IRS can be used by an entity to hedge an exposure to uncertain future interest rates, but it can also be used to bet on the direction of future interest rates.

42. In the aforementioned typical case where no money is transferred at the outset of the swap contract, the swap's initial present value is zero. Thus, the present value of the swap's fixed and floating payment legs are the same. Being identical, this pair of present values initially net out to zero, explaining the lack of cash transfer at the outset of a fair swap. To understand how the present value of the swap evolves over time, it is useful to understand the separate present values of the swap's fixed and floating legs and how they evolve.

43. The present value of the floating-rate payment leg anticipated by the swap buyer (paid by the swap seller) is the notional amount of the swap at each reset date of the floating rate. This insight derives from the fact that one U.S. dollar invested at LIBOR over the LIBOR accrual period returns the accrued LIBOR interest plus the dollar of principal. If the returned dollar is reinvested in LIBOR repeatedly until the swap matures, the sequence of short-term rolled over LIBOR investments has essentially the same cash flows as a purchase of a floating rate LIBOR note—the same as the payments of the LIBOR leg of the swap. Thus, the initial payment of one U.S. dollar is the only out-of-pocket cost needed to achieve the same sequence of the swap's floating interest payments plus its return of principal at maturity. Likewise, at each reset date, reinvesting the returned principal entitles the investor to the remaining future payments on the floating leg of the swap. This economic equivalence makes one U.S. dollar the present value of the swap's floating rate stream, both initially and at each reset date.

44. By contrast, as time elapses, the present value of the fixed rate payments depends upon the fixed rate negotiated by the parties and how fixed swap rates change as time elapses for swaps maturing on the same date as the original swap. If these subsequent fixed swap rates are higher than the swap rate contracted initially, the present value of the fixed rate payment declines below the notional amount and vice versa.

45. In sum, at swap initiation, if the swap rate that is set is fair, the swap's present value is typically zero. However, each day, as the fixed rate that is fair on new but otherwise identical swaps changes, one of the counterparties gains at the expense of the other counterparty. To prevent default risk, cash payments are often made by the counterparty who has lost money on the swap

to the counterparty that has made money, often via a clearinghouse intermediary. The discount rates and formulas that are used to assess how much money is lost or gained can also be used to identify the present value of a swap with a swap rate that is not fair—whether due to dealer collusion or to a different swap structure, as discussed below.

46. Market Agreed Coupon ("MAC) IRS are a category of highly standardized fixed-floating swaps. MAC swaps bear pre-specified fixed rates (also called "coupons") and have pre-specified forward-starting IMM dates in March, June, September, and December each year.[20] In this case, swaps with the same MAC and tenor, but agreed to on different days all have the same present value paths and are perfect substitutes for one another. Since the fixed rates or coupons offered on these IRS remain unchanged even as expectations of future interest rates and hence swap rates change, it is likely that the present values of the fixed rate payments differ from the present value of the floating-rate payments on the date this contract is accepted by two parties. Therefore, unlike many fixed-floating IRS, MAC IRS are traded with an upfront payment; the party receiving the higher present value has to pay its counterparty the difference between their present values (*i.e.*, the net present value of the swap) at initiation.

47. As discussed earlier, many fixed-floating swaps traded during the class period shared economic attributes that were uniform across investors. The significant degree of standardization in fixed-floating IRS is also evident from the fact that over the class period, about ■% of the notional volume of fixed-floating IRS reported to SDRs was cleared based on the SDR real-time report data described earlier.

48. It is important to note that, in the but for world, there would be even greater levels of standardization of IRS than existed in the actual world, because the availability of anonymous all-to-all trading promotes standardization.[21]

2. FRAs

49. FRAs are cash-settled contracts to exchange a negotiated fixed rate of interest for a

[20] *See* ISDA, Form of Confirmation for Market Agreed Coupon Swap (2013), https://www.isda.org/2013/04/24/market-agreed-coupon-mac-confirmation-form/.

[21] Anonymous CLOB-like trading in turn deepens the demand for standardized contracts. *See* Larry Harris *Trading & Exchanges: Market Microstructure for Practitioners* (2012), pp. 54, 184. Telser points out exchanges give rise to further standardization as "contracts become highly fungible and capable of being traded in a highly liquid market." *See* Lester G. Telser, "Why There Are Organized Futures Markets," *Journal of Law and Economics* (1981), pp. 1, 6.

reference rate (*e.g.*, USD LIBOR) on a designated notional amount for a specified period of time (*e.g.*, three months) starting at an agreed date in the future (the "settlement date").

50. As with non-MAC fixed-floating IRS, the key pricing element in an FRA is the fixed rate negotiated by the parties. It represents the forward rate for the reference floating rate at the agreement date. The payment from the FRA on the settlement date is the difference between this forward rate negotiated at contract inception and the spot reference rate prevailing at the future settlement date. Unlike traditional fixed-floating IRS, the fixed and floating legs of the swap exchange their payments at the beginning rather than the end of the interest accrual period. Also unlike traditional fixed-floating IRS where future payments are exchanged periodically, FRA counterparties exchange payments only once in the future.[22] As with traditional fixed-floating swaps, many of the FRAs traded by the class shared standardized economic attributes such as a fixed notional value in common currencies, common day-count conventions common floating rate indices, and common effective dates.

3. Overnight Index Swaps

51. OIS are fixed-floating swaps in which the floating rate is linked to an overnight reference rate reported by a central bank such as the U.S. Federal Funds overnight rate for USD swaps (instead of, for example, the 3-month 1-month, or 6-month USD LIBOR rate used in the traditional fixed-floating swaps described above).[23] The fixed rate negotiated by the parties is referred to as the OIS rate.

52. The payment terms of OIS differ from those of fixed-floating IRS. Interest payments accrue over the full tenor of the OIS and a single net payment is made at OIS maturity to the party with the higher accrued interest payments, based on the difference in the amount of daily compounded interest between the fixed and overnight rates. In order for an OIS to be fairly priced for both participants at inception, the OIS rate for a given tenor (say three months) has to relate to the three-month total rate of return expected to be realized by earning interest, compounded daily, at the sequence of (as yet unknown) daily overnight rates over the next three months. For tenors greater than one year, payments under an OIS pay accrued interest periodically

[22] *See* Remolona, Eli M., Philip D. Wooldridge, "The euro interest rate swap market," *Bank for International Settlements Quarterly Review* (March 2003), p. 47.

[23] *See* Corb, *Interest Rate Swaps and Other Derivatives*, p. 27.

during the life of the contract, usually at 12-month intervals.[24] The OIS traded by investors during the class period shared a common set of observable attributes with a high degree of standardization such as fixed notional amounts in common currencies, common tenors, common floating indices, and common effective dates.

4. Single-Currency Basis Swaps

53. A single-currency basis swap involves one floating interest rate being swapped for another; thus one party might agree to pay the 1-month USD LIBOR and receive the 3-month USD LIBOR.[25] When both rates are for the same currency (as in a single-currency swap), one dimension in which these rates can differ is their term to maturity (or "tenor"). In this case, the swaps are also called "tenor basis swaps." Alternatively, one party might pay the 3-month Treasury bill rate plus a negotiated spread for 3-month USD LIBOR over a sequence of payment periods.

54. The payments generated by these floating rates may have different present values because of (a) the term structure of interest rates; (b) different payment frequencies for the two legs of the swap (with the shorter-term rate being paid more frequently than the longer-term rate); or (c) different credit risk, liquidity, or tax advantages to one benchmark (*e.g.*, 90 day U.S. T-bill) rate vs. another (3-Month USD LIBOR). To equalize the present values of these payments, a fixed spread (typically in basis points or "bps") has to be added to the rate that generates the lower present value of payments. The key pricing decision in a single-currency basis swap is to set this fixed spread. Single-currency basis swaps traded by investors during the class period shared common economic attributes such as fixed notional amounts in common currencies, common effective dates and common tenors. By 2017, almost [redacted]% of basis swaps were centrally cleared, further indicating the suitability of many basis swaps to trade on an all-to-all platform.

B. Dealers and Class Members

55. As described below, dealers—typically large investment and commercial banks—act as "market makers" by offering to enter into swaps with other market participants at terms set by the dealer. The Dealer Defendants in this case are the large dealers that dominated the IRS

[24] *See* description of OIS by ClarusFT: Clarus Financial Technology (ClarusFT), *OIS Swap Nuances* (2015), https://www.clarusft.com/ois-swap-nuances/. The SDR transactions records indicate that OIS tenors greater than one year generally exchange payments at one year intervals.

[25] *See* Corb, *Interest Rate Swaps and Other Derivatives*, p. 28.

market. The counterparties on such swaps (the "buy side," essentially the members of the proposed class) may include other financial institutions, corporations, or investors.

56. My review of the SDR data and data produced by SEFs reveals that there are at least 8,000[26] potential class members, and that they encompass entities such as hedge funds, pension funds, insurance companies, endowment funds, asset managers, non-dealer banks, and other entities. My conclusions below apply irrespective of the type of class member that traded IRS.

C. IRS Suitable for Trading on an Anonymous All-To-All Platform

57. As I have stated, counsel have informed me that the proposed class consists of: All persons or entities, who, from January 1, 2013 to the present, entered into one or more fixed-floating IRS, OIS, single-currency basis swaps, or FRAs with the Dealer Defendants, or their respective affiliates, in the United States and its territories.[27] To provide context for my opinions and damages methodology, in this section, I discuss the common attributes of IRS traded by the class which are indicative of the feasibility of all-to-all trading.

58. Many IRS products within the four categories I analyze share observable contract attributes that I believe make it possible to identify, with reasonable accuracy, the swaps that would have migrated to anonymous all-to-all platforms. These contractual attributes are objective and can be readily specified. They are uniform across a large number of swaps that fall within the class definition and, over the class period, traded in higher frequencies and in greater notional volumes than swaps lacking the common attributes. The attributes are also consistent with the attributes used to define both MAC and MAT ("Made Available to Trade") swaps. MAC swaps were developed by ISDA to facilitate trading and transparency in the IRS marketplace. These swaps contain pre-agreed terms based on established, rolling maturity dates.[28] MAT IRS, as defined by the CFTC, are required to be centrally cleared and must be traded on a SEF, either on

[26] My estimate is conservative as it does not separately count members of the class whose IRS were transacted by asset manager or an investment manager. For example, if PIMCO executed a block trade on behalf of 20 customers, my estimate of the number of potential class members would only identify a single customer, PIMCO, and not the 20 post-block allocation customers. As my work continues, I will be able to identify the 20 post-block allocation customers.

[27] Excluded from the Class are Defendants, their co-conspirators, and their officers, directors, management, employees, and current subsidiaries or affiliates. Also excluded are any entities registered as "swap" dealers with the CFTC during the Class Period.

[28] SIFMA, *Market Agreed Coupon Contract*, https://www.sifma.org/resources/general/mac-term-sheet/.

a CLOB or via RFQs to a minimum of three dealers.

59. While certain in-scope IRS include customized features, among them, unique forward starting dates, fractional tenors, or difficult-to-interpret product terms—the vast majority share contractual terms that are well-articulated. Many swaps with these common attributes were traded on SEF platforms by members of the class. These swaps were also typically subject to the CFTC's central clearing requirement and, as Section II.A previously discussed, the transaction records I reviewed confirm they cleared in high volumes. Central clearing is a readily observed attribute that strongly indicates standardization of an IRS contract.[29] Central clearing also indicates that there must be depth and liquidity in the market for a particular swap in order for the CCP to value the centrally cleared instrument using reliable and acceptable pricing sources.[30]

60. Certain other economic criteria are strongly indicative of standardization (and thus suitability for anonymous all-to-all trading) as well. These attributes can readily be observed in the terms of these contracts. For example, I was able to observe such attributes in the Part 43 data which I supplemented with a review of the economic terms of swap records produced by the Bloomberg and Tradeweb SEFs. These attributes include specifications others have used to create MAC swaps,[31] define MAT swaps,[32] and to differentiate one Bloomberg IRS ticker from another.[33] My identification of common economic terms is also based on a review of documents produced in this matter.

61. The following list contains examples of such common attributes, which are shared across the majority of the traditional fixed-floating swaps traded by members of the class:

- notional amounts denominated in a common currency: U.S. Dollar (USD); Eurodollars

[29] For example, in January 2012, [redacted] noted that it "[redacted]." It also noted that "[redacted]", '504-506. [redacted].

[30] *See* ISDA, *Non-Cleared OTC Derivatives: Their Importance to the Global Economy* (March 2013), p. 18, https://www.isda.org/a/AeiDE/non-cleared-otc-derivatives-paper.pdf.

[31] *See* SIFMA, *Market Agreed Coupon Contract*, https://www.sifma.org/resources/general/mac-term-sheet/.

[32] *See* CFTC, *Swaps Made Available to Trade*, http://cftc.gov/PressRoom/PressReleases/ssLINK/swapsmadeavailablechart.

[33] *See* Appendices 3 and 4 for a discussion of Bloomberg IRS quote tickers that Bloomberg assigns to IRS with certain attributes such as currency, reference index, tenor, and payment and reset frequencies.

(EUR); the pound sterling (GBP); Japanese Yen (JPY); Canadian Dollar (CAD); Australian Dollar (AUD); and Swiss Franc (CHF);

- common floating rate reference index that is particular to the native currency of the swap, such as USD LIBOR or EURIBOR;[34]
- fixed notional amount (no amortizing terms);
- fixed-leg payment frequency that is quarterly, semi-annual or annual;
- fixed-leg interest rate day-count convention that is 30/360, actual/360 or actual/365;[35]
- floating-leg payment frequency that is quarterly, semi-annual or annual;
- floating leg interest rate day-count convention that is actual/360, actual/365, and;
- tenor with an integer value up to 30 years or a tenor based on IMM dates.[36]

62. In addition to possessing one of the alternatives listed above, fixed-floating swaps suitable for all-to-all platforms are likely to have one of the following attributes with respect to their effective dates:

- spot starting effective date;[37]
- IMM forward starting effective date;[38]
- integer forward effective date of one to 23 months or annually thereafter; or

[34] For example, based on the swap records reported to the SDRs, the floating leg of a swap denoted in U.S. dollars is typically based on an overnight to 12-month U.S. LIBOR. A swap in Eurodollars is commonly based on the 1-week to 12-month EURIBOR index or the overnight to 12-month EUR LIBOR.

[35] Within these three methods of accruing interest, standard industry practices recognize formulaic variations that are generally particular to a specific currency. For example, the day-count convention of 30/360 can be expressed as 30E/360, a convention sometimes called the Eurobond basis, and which is interpreted in the industry to mean that if either the first day or last day in the interest period falls on the 31st day of the month, the day value for computing the interest rate payment amount should be changed from 31 to 30. For purposes of identifying mutual factors in swaps traded by the class, when I refer to the three methods for computing interest, I am including standard industry formulaic variations.

[36] In determining whether the tenor of a swap had an integer value, I used the difference between the maturity and effective date, allowing for a +/- 3 day calendar window for transactions that became effective and matured on the same day of the week.

[37] Spot starting swaps can include periods such as T+0 or T+2. Such conventions are typically dictated by the native currency of the swap. When I describe spot starting swaps I consider all transactions where the effective date was within five calendar days or fewer of the trade date to adjust for transactions where the effective date is moved forward under common business day conventions to adjust for weekend days, holidays, or other days when the financial markets are closed.

[38] An IMM date corresponds to the 3rd Wednesday of March, June, September and December. SIFMA, *Mac Term Sheet,* https://www.sifma.org/resources/general/mac-term-sheet/. Similarly, there are swaps that start on key monetary policy dates, such as The Federal Open Market Committee Dates or the Monetary Policy Dates of the Bank of England. These swaps are standardized as to starting on these pre-defined dates.

- short, forward starting effective date less than 30 days.[39]

63. This list of characteristics has much in common with the IRS that are known as MAC swaps. As previously discussed, MACs are highly standardized fixed-floating IRS, required to be cleared, and highly suitable for exchange-like trading. MAC swaps possess pre-defined, market-agreed terms, similar to the terms I describe above. They have defined effective dates set to IMM dates, whole-year (integer) tenors, fixed coupon rates, fixed leg semi-annual payments, floating rate quarterly payments, actual/360 day-count conventions, and are traded in six currencies: USD, EUR, GBP, JPY, CAD, AUD.[40]

64. This list of characteristics also has much in common with the IRS known as MAT swaps.[41] Note how a USD fixed-floating MAT swap is presently defined and how the attributes of that definition are similar to those I have identified above as illustrative objective criteria for standardization.[42] My criteria, as well as the criteria for MAT swaps, have the following shared economic terms:

- transacted in three currencies: USD, EUR and GBP;
- no notional amortization;
- a floating rate index in the 3-month or 6-month LIBOR;
- spot starting effective date or an effective data on the next two IMM dates;
- fixed leg payment frequency of semi-annual or annual;
- fixed rate based on par or the then-current fixed coupon rates for MACs;
- fixed leg day-count convention of 30/360 or actual/360;
- floating leg payment or reset frequency of quarterly or semi-annual;
- a day-count convention actual/360;
- no dual currency trades; and

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[39] Short-date forward starting swaps are an example of a swaps that could be easily substitutable into spot starting or IMM forward starting swaps.

[40] *See* SIFMA, *SIFMA Asset Management Group Helps Develop New Market Agreed Coupon for Interest Rate Swaps*, https://www.sifma.org/resources/news/sifma-asset-management-group-helps-develop-new-market-agreed-coupon-for-interest-rate-swaps.

[41] Though MAT swaps feature highly standardized attributes, I do not believe they are a reliable proxy for what would have traded on anonymous all-to-all platforms in the but for world, in part because the presence of viable anonymous all-to-all trading platforms increases volumes and standardization. I discuss this phenomenon more in Section IV.B.

[42] *See* CFTC, *Swaps Made Available to Trade*, http://cftc.gov/PressRoom/PressReleases/ssLINK/swapsmadeavailablechart.

- whole tenor of 2, 3, 4, 5, 7, 10, 12, 15, 20, or 30 years or IMM end/roll date conventions.

65. The criteria I have identified as being indicative of standard terms however subsume those of fixed-floating MAT swaps and are broader. Currently, MAT swaps include only fixed-floating swaps, though standard attributes exist for FRAs, OIS, and basis swaps that would make swaps in these other product categories suitable for anonymous all-to-all trading. In addition, IDB platforms supported the trading of these three product categories on the IDB CLOBs. For example:

- A December 2013 [redacted] email explains that its [redacted] The email states that [redacted].[43]
- A June 2014 [redacted] presentation [redacted].[44]

66. Thus while the MAT designation for fixed-floating swaps is presently limited to swaps denominated USD, EUR and GBP, it is my opinion that IRS traded in additional denominations—and the common floating rate indices particular to each—are sufficiently standardized to be suitable for anonymous all-to-all trade, including IRS in JPY, CHF, CAD, and AUD. I also include a broader range of tenors relative to MAT IRS. As another example, MAT swaps are further limited to those with semi-annual or annual fixed leg payment frequencies. I also include quarterly payment frequencies.

67. While the criteria I just described to identify swaps suitable for anonymous all-to-all trading are broader than the criteria currently used to specify MAT swaps, my listing is still very conservative. For example, certain swaps traded by the class included swaps with highly standardized features, but exchange fixed-for-floating cash flows in the Mexican Peso, Brazilian Real or other currencies. Although less actively traded than similar swaps that trade the currencies on my list above, swaps in the Mexican Peso and Brazilian Real are suitably standardized to trade

[43] *See* [redacted], at '086-094.

[44] *See* [redacted], at p. 19.

on an anonymous all-to-all platform.[45] And consistent with MAT contracts, other IRS that may be suitable for anonymous all-to-all trading are package trades whose individual legs are suitable for anonymous all-to-all trading.

68. Some class members traded swaps with fractional tenors, such as 4.6-year tenor. There are several ways in which anonymous all-to-all trading might arise for this swap. Since all of its other economic terms reflect the common terms on my list, or can be slightly altered to make the swap suitably standardized, it is possible that the 4.6-year fractional tenor swaps could trade on, for example, an all-to-all RFQ platform. Alternatively, a 4.5-year tenor falling on an IMM date may be standardized enough to warrant exchange trading. In this case, a 4.6-year tenor may simply convert to a 4.5-year tenor swap if exchange trading is more convenient, transparent and cheaper than bilateral OTC trading of a 4.6-year swap. The same principle of anonymous all-to-all RFQ or migration to CLOB-traded contracts with nearly identical features would hold true for other swaps as well. These other swaps merely need to possess some of the key standard terms described above. In this case, exotic fractional forward effective dates or back starting intervals could end up being improper excluding criteria, according to my list. It is also possible that a 4.6-year tenor could substitute into either a 4-year or 5-year tenor. In the but for world, I would expect trading in common tenors would be higher as investors substitute into standardized IRS that would be trading at significantly lower spreads.

69. As noted above, the four product types I analyze in this report—fixed-floating IRS, OIS, FRAs, and basis swaps—are centrally cleared in high volumes and many are traded on SEFs. These products are also all traded on inter-dealer electronic platforms. Because central clearing and SEF trading mean that a product is both standardized and relatively liquid, the majority of swaps within these categories are suitable for anonymous all-to-all trading.

70. Evidence produced in discovery confirms that Defendants also recognized that most IRS products are suitable for anonymous all-to-all trading or would have received direct benefits from the emergence of such platforms. For example:

- [redacted] Bank, testified that [redacted]

[45] A December 2013 email produced by [redacted] indicates that [redacted] at '086-'095.

[redacted][47]

- As early as 2009, [redacted] stated in an internal report that [redacted][48]
- [redacted] estimated in a June 2011 email that [redacted]"[50]

71. Similarly, a [redacted] study titled "[redacted] (November 2010) indicated that [redacted][51] Even swaps that might not migrate to all-to-all platforms will have different terms in the but for world. Section V discusses how to measure damages for these instruments.

72. While I believe it is possible to identify, with reasonable accuracy, the swaps that would have migrated to anonymous all-to-all platforms, to be conservative, my damages methodology generally assigns lower spread compression rates to any class member's IRS transaction that was not traded on a SEF and cleared in the actual world irrespective of whether I have a high degree of confidence that that type of IRS transaction would have traded on anonymous all-to-all platforms (or been substituted for instruments that did) in the but for world.

[46] Deposition of [redacted] December 12, 2018, 31:20-24.

[47] Deposition of [redacted] February 13, 2019, 300:9-16.

[48] *See* [redacted], at '400.

[49] [redacted] Ex. [redacted]

[50] Deposition of [redacted] November 29, 2018, 339:340:20-341:8.

[51] *See* [redacted] at '196.

D. Dealership and Bid-Ask Spreads

1. Bid-Ask Spreads

73. In principle, a buy-side entity interested in executing an IRS transaction could do so with any other party willing to take the opposite side of the trade. In practice, Plaintiffs allege that both before and during the proposed class period, Defendants' actions prevented buy-side entities from entering into IRS with other buy-side entities, forcing them to trade only with IRS dealers, largely a group of investment banks (also known as the "sell side"). In what is sometimes called a "market-making" capacity, dealers buy and sell IRS—not due to an intrinsic economic interest in those positions—but rather, to provide immediate execution to a buy-side entity. Thus, a dealer might agree to receive fixed rate interest from a buy-side investor in a traditional fixed-floating swap with the expectation that another buy-side investor will express an interest in receiving fixed. By entering into an IRS with this new investor and paying fixed, the dealer reduces or eliminates its financial exposure to the interest rate risk generated by the first fixed-floating swap.

74. In exchange for providing immediate execution, the dealer charges a *bid-ask spread* on the fixed rate leg of the swap. The bid-ask spread is commonly defined as the difference between the offer rate (also known as the "ask") and the purchase rate (also known as the "bid"). In non-MAC traditional fixed-floating swaps or OIS, the offer and purchase rates would be for receiving and paying the swap rate, respectively; in FRAs, bids and offers pertain to the forward rate, and in basis swaps, they pertain to the spread to one of the floating rate pairs (typically, the shorter maturing floating rate in a tenor basis swap). When IRS are bought and sold, dealers do not charge separately for or itemize the bid-ask spread. Rather, this mark-up is embedded in the swap rate, forward rate, or spread to the floating rate. By charging a bid-ask spread, the dealer ensures a rate that is, from the dealer's perspective, more favorable than the "true" fixed rate, whichever side the dealer is on.

75. For example, if the "true" fixed rate in a traditional fixed-floating 5-year IRS on the 3-month USD LIBOR is 4.560% and a buy-side investor expresses an interest in paying fixed, the dealer may "ask" a fixed rate of 4.562% to receive fixed, ensuring that it receives a half-spread profit of 0.002% (or 0.2 basis points) above the actuarially fair fixed rate to provide immediacy. Likewise, when trading with a buy-side entity seeking to receive fixed, the dealer may "bid" to pay a fixed rate of only 4.558%, thus capturing a half-spread profit of 0.002% (or 0.2 basis points)

on paying fixed.

76. Collectively, in this example, the spread between the ask rate received by the dealer and the bid rate paid by the dealer is 4.562% less 4.558%, *i.e.*, a bid-ask spread of 0.004% (or 0.4 basis points). The dealer earns half the spread (or a "half-spread") of 0.2 basis points on each of its transactions (paying and receiving fixed) and 0.4 basis points on a "round-trip." A similar bid-ask spread applies to the swap rate in OIS, the forward rate, and the constant premium (or "basis spread") generally attached to the shorter-horizon rate in a floating-for-floating tenor basis swap.[52]

77. For IRS that entail multiple payments of the fixed rate (such as fixed-floating IRS or OIS), the buy-side investor pays the dealer's half-spread not just once, but rather, every time it pays or receives fixed, such as semiannually or quarterly. Thus, if the half-spread on a 5-year IRS is 0.2 basis points, the buy-side investor incurs a charge of 0.2 basis points multiplied by the notional amount each year for five years. For example, if the swap had been priced on terms that involved semiannual coupon payments and the half spread was 0.2 basis points, the buy-side investor would pay the dealer's half spread five times. This stream of transaction costs paid to the dealer may, in present value terms, be almost five times the annual cost over the five-year horizon of the swap. For such multi-payment IRS, I refer to this present value of spread-related costs over the life of the swap as the "upfront spread" or the "upfront price of liquidity."

78. As noted above, bid-ask spreads charged for dealership services cannot be measured directly from available data on IRS transactions. I use well accepted methods from statistics and economics to infer the bid-ask spread from other information contained within transaction records, including the fixed swap rates of the affected transaction, and subsequent transactions. Section V describes how the bid-ask spread for an IRS during the proposed class period can be inferred from available data.

2. Factors Affecting Bid-Ask Spreads

79. While dealers charge a bid-ask spread on each IRS transaction, the magnitude of this spread may vary at a given time across contracts, and across time for a given contract, depending on the influence of several factors. The methodology described in Section V

[52] I used the term "half-spread" to refer to one half of the bid-ask spread. The term "spread" should not be confused with the commonly used term "spread" that refers to the relative difference between two rates, such as the difference in yields between two securities, the spread to one floating rate in basis swaps, the spread to on-the-run Treasury yields (known as the "swap spreads") the determines the fixed rate in traditional fixed-floating IRS, or the spreads that result from the simultaneous purchase of one financial instrument and sale of another.

incorporates each of these factors by examining all trades that occurred from 2013 through 2017, where the level of the factor or its importance to bid-ask spreads would have varied. I thus mention these factors only briefly and for the sake of completeness.

80. ***Monopoly Power and Pricing Transparency.*** In a competitive market, economic profits, accounting for all opportunity costs, are zero.[53] Hence, one factor that influences the size of the bid-ask spread is the degree to which competition is restrained by collusion or conspiracy. The Nobel prize winning work of Peter Diamond shows that search costs can generate monopoly power.[54] Hence, if price discovery is hindered in any way, and it is costly for buy-side investors to find alternatives, monopoly pricing in the form of higher bid-ask spreads may ensue. Economic science implies that even in the absence of collusion, in a market structure with a limited number of quotes, it is rational for dealers to charge a larger bid-ask spread than that from the competitive outcome. A market's degree of price transparency and information about prices for recent transactions on the same or comparable financial instruments have been shown to contribute to lower bid-ask spreads in the academic literature, as described in Section IV below.

81. ***Dealer Costs for Providing Immediacy.*** In a competitive market, the costs of providing dealership services must be compensated for. These include the cost of providing trade tickets, dealer labor costs, technology investment, and dealer payments to service providers. Dealers may also impose a capital charge for the funds needed to support the inventory of IRS held.

82. ***Dealer Risks from Asymmetric Information.*** The largest risk faced by dealers trading with a buy-side counterparty is that the market price of the aggregate dealer position on IRS will move in an unfavorable direction before the aggregate IRS position is offloaded or offset by another transaction. Equity markets have larger bid-ask spreads because dealers enter into trades with insiders or other parties who have better access to information about a firm's prospects. By contrast, in the case of IRS, dealers are the primary parties that interact with the Federal Reserve and corporate issuers. They also observe institutional trade flows in a variety of interest-sensitive

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[53] *See* Michael R. Baye, *Managerial Economics and Business Strategy* (McGraw-Hill/Irwin, 2010, 7th edition), p. 277; Roger D. Blair and David L. Kaserman, *Antitrust Economics* (Irwin, 1985, 1st edition), p. 21; Walter Nicholson, *Microeconomic Theory: Basic Principles and Extensions* (South-Western, 2002, 8th edition), p. 383; Dennis W. Carlton and Jeffrey M. Perloff, *Modern Industrial Organization* (Pearson, 2005, 4th edition), pp. 245-247.

[54] *See* Peter Diamond, "A Model of Price Adjustment," *Journal of Economic Theory* (1971), pp. 156-68.

and credit-sensitive securities. Dealers are the main participants in auctions of securities by the U.S. Treasury, government agencies, and municipalities, placing orders as principals and agents, and observing demand from their own customers in the auction. Dealers also make markets in "when-issued" securities, *i.e.*, securities that begin trading on a conditional basis when they have been announced but not yet issued. Transactions in such when-issued securities effectively bet on the outcomes of auctions for fixed income securities before these auctions even occur, gaining insight into future supply and demand for interest rate instruments. Dealers also have greater insight into the economy's level of credit risk and liquidity. Finally, dealers tend to have sophisticated departments employing many economists who model credit risk and future interest rates as part of their macroeconomic forecasts. These factors suggest that the dealers are unlikely to be at any systematic information disadvantage vis-à-vis their customers.

83. Dealers also quickly offload or offset most IRS positions to other dealers or buy-side customers. In this sense, dealers are like casinos. The bid-ask spread is like a skewing of the odds on a casino game. The dealer, like the casino, may win or lose on a particular bet. However, since they make numerous short-term bets (both that interest rates will increase and will decrease), the law of large numbers tends to generate a consistent stream of near riskless profit with the odds stacked in their favor.

84. ***Dealer Risks from Chance Events, Volatility, and Low Buy-Side Depth.*** Dealers face some temporary risks, by chance. For example, if a sequence of trades happened to put a dealer into a net position of receiving a fixed rate, the dealer may need some time to hedge or offload the position to become more neutral with respect to chance interest rate movements. The risks are greater if the security is more volatile. If the depth of buy-side trading interest in an IRS instrument is large, the likelihood that a chance adverse movement in interest rates will affect dealer profits is small, as the risk of the position will be transferred to the buy side relatively quickly.

85. IRS instruments trading in a dealer-centered market that differ in the depths of buy-side trading interest could have different competitive bid-ask spreads. However, in competitive anonymous all-to-all trading, buy-side depth tends to be high. Moreover, at times when dealers cannot serve up a competitive quote (*e.g.*, because it would add to the interest rate risk of dealers' existing position), anonymous all-to-all trading also serves as a conduit for meeting the needs of other buy-side investors at low trading costs. Because such all-to-all trading does not force dealers

to quote prices if they cannot profit from such quotes, bid-ask spreads observed in such markets tend to be lower. Dealer-centric markets, by contrast, force buy-side investors to pay for the inventory risks of dealers.

III. THE IRS MARKET FAILED TO EVOLVE TO ANONYMOUS ALL-TO-ALL TRADING AS ECONOMIC THEORY AND EXPERIENCE IN PARALLEL MARKETS PREDICT

86. This section analyzes the economic forces that would have generated the but for world in which anonymous all-to-all trading should have taken place, but for the alleged conspiracy. The section first summarizes the research on markets for other financial instruments which have evolved from dealer-centered OTC markets to anonymous all-to-all trading platforms but lacked the evolutionary obstruction posed by the alleged conspiracy. I then discuss the IRS market structures that existed from inception to just prior to regulatory reform and the changes brought about by Dodd-Frank regulatory reform. Finally, I analyze the period from Dodd-Frank implementation to now, noting that despite these regulatory developments, buy-side firms' post-2013 IRS trading environment remains similar to the environment prior to 2013.

87. The evolution of markets for other financial instruments highlights the lack of similar progress experienced in the IRS market. This lack of progress is especially poignant in light of the fact that IRS represent one of the very largest classes of financial products in the world. The notional at risk in IRS is many times greater than the collective value of all shares listed on U.S. Stock Exchanges—exchanges that trade thousands of stocks, each of which is more idiosyncratic than almost any type of IRS. And each of these unique stocks is associated with dozens and sometimes hundreds of options with differing features available for anonymous all-to-all trading on options exchanges.

A. OTC Markets Generally Evolve to Anonymous All-to-All Trading

88. Perfect competition in which companies earn no economic profit after accounting for all costs, including the cost of risk-bearing, is the natural state of most markets. Anti-competitive structures tend to break down over time since the lucrative monopoly rents earned by businesses in anti-competitive markets entice new entrants and more attractive pricing from existing businesses. To the extent that anonymous all-to-all trading is more efficient for distributing IRS than the OTC markets with name give-up that exist today, pressures will arise over time that reduce bid-ask spreads and ultimately, market structures will evolve that dominate

the current system. The inevitable progression to more efficient and more competitive markets halts only when obstacles are imposed—by the legal or regulatory barriers of government institutions, illegal collusion, or information frictions.

89. Foucault et al. (2013) make several salient observations about market readiness for competitive CLOB exchange trading. First, "[t]echnological advances in information and communication technologies for securities trading have greatly facilitated entry into the market for the provision of trading services. The cost of setting up an electronic platform such as a LOB is now extremely low."[55] Second, the technologies for "fully electronic LOB" exchange trading have become widely available, and many of the trading systems using these technologies have become a "blueprint for others."[56] As pointed out by the Nobel Prize winning economist Paul Romer, the technology "blueprint" is a key impetus behind competitive, dynamic economic growth.[57]

90. The authors of a 2016 Bank for International Settlements ("BIS") report observed the rapid change from competition in the fixed income markets brought about by the growth and diffusion of electronic communications networks that underpin CLOB platforms. The technology has "allowed new competitors with lower marginal costs to reduce margins and force efficiency gains" which in turn "improve market quality for assets that were already liquid by increasing competition."[58] Many markets encompassing a broad range of securities and derivatives, as discussed below, have evolved to electronic all-to-all trading as consequence of this technology.

91. ***U.S. Treasuries***. The same authors of the 2016 BIS report note that the market in "on-the-run [liquid] US Treasury securities is almost entirely electronic, with a CLOB and a large presence of PTFs" or proprietary trading platforms.[59] Mizrach and Neely (2006) describe the intense competition around the introduction of limit order trading platforms in the U.S. Treasury market.[60] Following the diffusion of CLOB technology adopted by the equity markets, several

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[55] *See* Thierry Foucault, Marco Pagano, and Alisa Röell, *Market Liquidity: Theory, Evidence and Policy* (Oxford University Press, 1st edition, 2013), p. 36.

[56] *Id.* at p. 38.

[57] *See* Paul Romer, "Endogenous Technological Change," *Journal of Political Economy* (1990) p. 75.

[58] *See* Markets Committee Report, "Electronic trading in fixed income markets," Bank for International Settlements (2016) p. 1.

[59] *Id.* at p. 10.

[60] *See* Bruce Mizrach and Christopher J. Neely, "The Transition to Electronic Communications Networks in the Secondary Treasury Market," *Federal Reserve Bank of St. Louis Review* (2006) pp. 531-536, 539.

innovators, including Cantor Fitzgerald, brought these technologies to the secondary market for on-the-run U.S. Treasury bonds. As the authors describe, a competitive race ensued leading to alternative electronic platforms with varying capabilities that ultimately resulted in greater market participation, greater trading volumes, and lower trading costs.

92. ***Stock Options.*** Prior to 1973, equity options were traded over-the-counter via a dealer market.[61] Compared to IRS, equity options seem like one of the last types of securities that would be ripe for such trading. One reason is that equity option prices are very sensitive to information about a company's future prospects. An insider with information about a company that other investors lack can make much more from that information per dollar invested in equity options than in the equity itself. Another reason is the large number of option securities per company, differentiated by a plethora of strike prices, expiration dates, and whether they offer the right to buy or sell the stock.

93. One could argue that in the face of this information asymmetry and the large number of slightly differentiated products, anonymous all-to-all trading of options would be an improbable structure. Yet, in 1973, the Chicago Board Options Exchange created the first anonymous all-to-all trading platform for options.[62] It was a huge success, dramatically lowering the cost to buy-side investors of trading in the options markets and raising the volume of option trading.[63] It was soon mimicked by other new exchanges: for example, both the Philadelphia[64] and American Options Exchange[65] commenced trading in 1975. Due to advances in technology, the cost of setting up such markets today is far cheaper.

94. ***Equities***. Centralized order book technologies have been adopted in most, if not all, equity markets, both in the U.S. and in major financial centers around the world. The capabilities of order book technology are continuously exploited in response to competitive forces.

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[61] *See* Chicago Board Options Exchange (CBOE), *CBOE History*, http://www.cboe.com/aboutcboe/history.

[62] *Id.*

[63] *See* Myron S. Scholes, "Derivatives in a Dynamic Environment," *Nobel Lecture in Economic Sciences* (1997) pp. 127, 137; Joseph E. Finnerty, "The Chicago Board Options Exchange and Market Efficiency," *Journal of Financial and Quantitative Analysis* (1978) pp. 29-38.

[64] *See* The Historical Society of Pennsylvania, *Collection 3070: Philadelphia Stock Exchange Papers* (2006) p. 7, https://hsp.org/sites/default/files/legacy_files/migrated/findingaid3070phlx.pdf.

[65] *See* New York Stock Exchange (NYSE), *American Stock Exchange Historical Timeline*, https://www.nyse.com/publicdocs/American_Stock_Exchange_Historical_Timeline.pdf.

For example, studies point to the NYSE and other exchanges' use of computerized information and network technology that disseminates order book price information as a hook to attract more clients.[66] Studies also observe that exchanges generate price information and enhance efficiency.[67] These studies demonstrate the continuous improvement of centralized order book technology to initiate structural change and continued incremental improvements.

95. ***Energy swaps***. In 2012, Intercontinental Exchange ("ICE") announced it would convert all of its cleared OTC energy contracts into futures contracts.[68] The impetus behind the transition stemmed from several forces including regulation, technology, and competition for customers. For example, at the time ICE announced the move to energy futures contracts, ICE said it was responding to rapid technological innovation driving the evolution of its entire options platform, which in one year had gone from being 10 percent electronically traded to 75 percent electronic.[69] The President of ICE stated that its electronic trading platform better served market participants seeking "functionality, transparency and efficiency of the platform."[70] Once the transition of ICE's energy swaps to futures contracts was underway, ICE accelerated the move from OTC to futures exchange in response to "the strong preference of our customer base to trade futures as soon as practical."[71] While regulatory factors may have also played a role in the transition,[72] ICE's announcements reveal that its platform conversion was a necessary reaction to competitive market factors. The speedy transition to an exchange-traded futures platform, and the market's willingness to embrace such a contract, illustrates how quickly competitive forces can converge to change trading regimes from OTC to anonymous all-to-all trading.

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[66] *See* Boehmer, Ekkehart, et al., "Lifting the Veil: An Analysis of Pre-Trade Transparency at the NYSE," *The Journal of Finance* (2005) pp. 783-815; Eom, Kyong S., et al., "Pre-trade transparency and market quality," *Journal of Financial Markets* (2007) pp. 319-341; Sakawa, Hideaki and Ubukata, Masato, "Does Pre-trade Transparency Affect Market Quality in the Tokyo Stock Exchange?" *Economics Bulletin* (2012) pp. 2104, 2108, 2109, 2110.

[67] *See* Jeffrey M. Netter, J. Harold Mulherin and James A. Overdahl, "Prices are Property: The Organization of Financial Exchanges from a Transaction Cost Perspective," *The Journal of Law & Economics* (1991) pp. 591-644.

[68] *See* Hal Weitzman, "ICE shifts OTC energy swaps to futures," *Financial Times* (2012).

[69] *See* Intercontinental Exchange, *ICE Futures U.S. to Complete Transition to Electronic Trading* (2012), https://ir.theice.com/press/press-releases/all-categories/2012/07-26-2012.

[70] *Id.*

[71] *See* Intercontinental Exchange, *Intercontinental Exchange to Transition Cleared Energy Swaps to Futures in October* (2012), https://ir.theice.com/press/press-releases/all-categories/2012/09-04-2012a.

[72] *See* Robert Litan, "Futurization of Swaps: A Clever Innovation Raises Novel Policy Issues for Regulators," *Bloomberg Government* (2013) p. 1.

96. ***Currencies***. Unlike stocks, futures, and most other securities and derivatives, currencies trade in relatively unregulated markets. Spot transactions in currencies have traditionally been conducted in dealer-centric OTC markets. However, in recent years, a growing share of currency trading has occurred on electronic multi-bank platforms that allow multiple dealing banks to compete by quoting simultaneously in response to customer requests. These multilateral platforms are analogous to IDBs that operate in the fixed-income securities and IRS markets. [73] A study by the Bank of England (2010) found that the share of spot foreign exchange transactions executed on electronic multi-bank platforms experienced 85% growth between 2007 and 2010.[74] Osler, Bjonnes, and Kathitziotis (2016) show that transaction costs for customers in foreign exchange transactions are lower in such multi-bank electronic platforms than in single-bank platforms or in direct transactions with desks of individual dealers.[75] As the authors note, multi-bank platforms provide the lowest transaction costs because they facilitate more competition among dealers.[76]

97. Thus, here, in line with the evolution of markets for other classes of financial products, I conclude that in the absence of artificial restraints to market competition, increasingly sophisticated and low-cost anonymous all-to-all electronic markets would have attracted the trading of standardized IRS onto their platforms and away from the currently bifurcated, non-anonymous market. The progression of financial markets is consistent with plaintiffs' allegations that collusive actions by the Defendants have prevented the migration of standardized IRS to anonymous all-to-all trading.

98. I have also reviewed the expert report of Professor Darrell Duffie in this matter. Professor Duffie is widely recognized as one of the foremost experts on OTC market structures (including expertise in fixed income products, such as IRS), and his work is well-respected in the field of economics. He is frequently called upon by government regulators for his extensive knowledge of OTC markets, and has conducted ground-breaking research into asset pricing in

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[73] *See* Bruce Mizrach and Christopher J. Neely, "The Transition to Electronic Communications Networks in the Secondary Treasury Market, *Federal Reserve Bank of St. Louis Review* 88(6) (November/December 2006) p. 534.

[74] *See* Tristan Broderick and Chris Cox, "The foreign exchange and over-the-counter interest rate derivatives markets in the United Kingdom, Bank of England," *Quarterly Bulletin* (2010) p. 360.

[75] *See* Carol Osler, Geir Bjonnes, and Neophytos Kathitziotis, "Bid-Ask Spreads in OTC Markets," Working Paper (2016) p. 13, 33, and Table 3. Transaction costs paid by the consumer are measured as the difference between the price paid by the consumer on a transaction and the interbank quote at the time of the transaction.

[76] *See id.* at pp. 10-11.

OTC markets.

99. Professor Duffie's analysis concurs with my own opinion: that the natural competitive outcome was blocked by some other force. If proven true, the alleged conspiracy, with its bifurcated name give-up D2C and D2D markets, enforced by threats and liquidity boycotts of competing structures, would, from an economic market structure perspective, be the most credible explanation of the IRS market's failure to achieve the natural competitive outcome.

B. The Historical Trading Protocols in the Highly Opaque OTC Market for IRS

1. Voice OTC and Why It Hurts Buy-side Investors

100. When the market for IRS emerged in the 1980s, it was an OTC market with little pre- or post-trade price transparency.[77] An IRS dealer was on one side of virtually every IRS transaction.[78] Buy-side trades with dealers were executed mostly via voice, with a small amount of trading done electronically.

101. As a 2008 [redacted] presentation explained, [redacted][79] [redacted][80] [redacted][81]

102. Similarly, a September 2010 [redacted] presentation notes, "[redacted]

[77] *See generally* Anatoli Kuprianov, "Over-the-Counter Interest Rate Derivatives," *Federal Reserve Bank of Richmond Economic Quarterly* (1993).

[78] A July 2011 [redacted] entitled, "[redacted] at '685.

[79] *See* [redacted] at p. 16.

[80] *See* [redacted] at '528 ([redacted]

[81] *Id.* at '529.

[redacted][82] As a 2010 [redacted] presentation put it: "[redacted] The same presentation noted that "[redacted]," that there was a [redacted][83]

103. Compared to anonymous all-to-all trading, voice trading with dealers is relatively more costly for buy-side clients. For one, clients must first contact the dealer and identify themselves to obtain a quote. This trading regime's lack of pre-trade price transparency and abundance of pre-trade name transparency gives the dealer a negotiation advantage. The dealer may know which buy-side clients are more aware of current market prices and which are less likely to be aware that better prices exist elsewhere. The dealer also knows that gathering quotes sequentially from other dealers is time-consuming and costly, even for the most sophisticated buy-side clients. With greater search costs, all buy-side clients are likely to accept wider bid-ask spreads rather than risk a market that moves away from them.

104. The manual process of voice-based price discovery tends to cause poor buy-side trade decisions because the odds are stacked against them. Formal models, discussed shortly, as well as common sense, suggest that executing at an adverse price is inevitable when the buy-side client has only stale information and, unlike the dealer, is unaware of the fair price. However, even in instances when the client rejects the dealer quote, the dealer still has obtained information about the clients' trading intentions. The dealer can then "front-run" the client, placing a similar order at a more favorable price and cause the client to trade with other dealers (or return to the original quoting dealer) at a less favorable price.[84] From the buy-side client's perspective, it will seem as if every time the client wants to trade a swap and inquires about a price, the price of the swap has moved directionally away from the client before the trade is executed, making the trade more expensive.

105. Separate from these direct trading costs, non-automated prices can move quickly and with stealth between the time when quotes are collected and the time the buy-side investor

[82] *See* [redacted] at '344.

[83] *See* [redacted] ([redacted]) at pp. 11-12.

[84] *See* Larry Harris, *Trading & Exchanges: Market Microstructure for Practitioners* (Oxford University Press, 1st edition 2003), pp. 245-46.

completes its trade. This delay could make the trade's structure and size, as well as pricing terms, inferior for the market conditions that are relevant for the buy-side investor's trading strategy at the time the swap becomes effective. Thus, voice quotes sometimes lead to trading errors and miscommunication, and create hedging mistakes and unnecessary risk because of the stale (or misheard) information inherent in their manual collection.

2. SDP and other RFQ Platforms: Voice in a Machine's Clothing

106. In the pre-Dodd-Frank era, the limited electronic trading available to the buy side took place via chat (such as Bloomberg chat), single-dealer platforms ("SDPs"), or the multi-dealer platforms operated by Tradeweb and Bloomberg.[85] [redacted][86]

107. [redacted][88]

108. As a 2010 [redacted] document put it, [redacted][89] Defendant [redacted]

[85] *E.g.*, Deposition of [redacted] September 26, 2018, 92:19-93:6 ([redacted]

[86] *See* [redacted] at '217 (Autobahn (Deutsche Bank), BARX (Barclays), MorganDirect (JP Morgan)).

[87] *See* [redacted] at '344; *see also* [redacted] at p. 3 [redacted] at p. 11–12 [redacted] at '224 [redacted]

[88] Deposition of [redacted] September 26, 2018, 92:19-93:6.

[89] *See* [redacted] at '722. This discussion focuses on RFQ trading of Treasuries offered on Tradeweb and Bloomberg, but is relevant in the context of describing RFQ trading protocols more generally.

[redacted][90] As characterized by a 2012 [redacted] document, "[redacted][91]

109. Prior to Dodd-Frank's introduction of the SEF trading platform, briefly described earlier as a Swap Execution Facility, the price from an RFQ quote was not a firm commitment for a trade at that price, [redacted].[92] These quotes were merely starting points rather than instantaneously actionable prices at which the customer can trade. Trades only take place once a negotiated agreement on a price are entered into. [redacted][93]

110. [redacted][94] As Defendant [redacted] explained, [redacted][95]

3. RFS

111. [redacted][96] [redacted]

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[90] *See* [redacted] ([redacted] Ex. [redacted] at p. 1, 2, 10; [redacted] ([redacted] Ex. [redacted]) at p. 2.

[91] *See* [redacted] at '393.

[92] *See* [redacted] at p. 4.

[93] [redacted] *See* discovery document [redacted]

[94] *Id.*

[95] *See* [redacted] at p. 5.

[96] *See* [redacted] at pp. 4, 7; *see also* I[redacted] (September 23, 2013 email [redacted]

[redacted][97] [redacted]

[redacted][98] The [redacted]

[redacted][99] [redacted]

[redacted][100]

4. The IRS Market Remains Functionally OTC

112. The aforementioned trading protocols functioned to preserve the bilateral, OTC nature of the IRS market. As summarized by a 2018 Bank of England Staff Working Paper, historically, "swap trading was decentralized and opaque" before the introduction of SEFs.[101]

113. Despite the opaqueness of the pre-Dodd-Frank IRS market, many institutional features had been developed that laid the groundwork for anonymous all-to-all trading. For example, to expedite the process of initiating new IRS, buy-side entities entered into industry-standard ISDA Master Agreements with counterparties, stipulating standardized specifications for a variety of terms that affect the swap's payments, such as the choice of holiday calendars used to define business days. With the onset of SEF trading under the Dodd-Frank mandates (described below), standardization has increased even further, with certain IRS contracts being defined homogenously across all market participants and required to be transacted on SEFs. Another feature that was introduced for some counterparties was central clearing, which I discuss below.

C. Central Clearing of IRS Transactions

114. As noted earlier, a clearinghouse "is an intermediary between buyers and sellers in the derivatives market. As the intermediary, or counterparty, to trade[s], [a clearinghouse] acts as

[97] *See* [redacted] at pp. 4, 8.

[98] *See* [redacted] at '489-'490.

[99] *See* B[redacted] at '880.

[100] *See* [redacted] at '059–'060.

[101] *See* Evangelos Benos, Richard Payne and Michalis Vasios, "Centralized trading, transparency and interest rate swap market liquidity: evidence from the implementation of the Dodd-Frank Act," Bank of England Staff Working Paper No. 580 (2018) p. 2.

the buyer for every seller and the seller for every buyer for [those] trade[s]."[102] A clearinghouse nets winners against losers. Thus, central clearing reduces default risk to parties who are owed money by the clearinghouse. Even if one party that owes the clearinghouse money defaults on its swap obligation, the clearinghouse serves to dilute that risk against all paying counterparties who similarly owe money on their swaps, but faithfully pay their obligation.

115. The clearinghouse also reduces risk by a margin (or cushion) in advance from which it can draw to finance payments owed by a swap counterparty. The margin accounts are "marked-to-market," collecting cash or paying cash according to formulas tied to the IRS present value. This margin feature is common to anonymous all-to-all markets in many securities and derivatives.[103]

116. The clearinghouse is essentially a collection of members who pool the risks from counterparty default by joining the clearing house. For IRS, "[c]learing members provide access to [the clearinghouse] for customers and must be registered as a Futures Commission Merchant (FCM)."[104] According to ClarusFT, a third party that reports on swap market trends, the top-ranked FCMs from 2014-2016 were almost entirely the Dealer Defendants.[105] The top-ten FCMs also accounted for 96% of all FCM-cleared OTC swaps during these three years.[106]

117. "The FCM guarantees the financial obligations of the customer to [the clearinghouse]."[107] The clearinghouse, in turn, "[i]nsures clearing members against counterparty

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[102] *See* CME Group, *What is Clearing?*, https://www.cmegroup.com/education/courses/clearing/what-is-clearing.html.

[103] *See* Craig Pirrong, "The Economics of Central Clearing: Theory and Practice," ISDA Discussion Paper Series No. 1 (2011) pp. 5, 7.

[104] *See* CME Group, *What is Clearing?*, https://www.cmegroup.com/education/courses/clearing/what-is-clearing.html.

[105] According to ClarusFT, the top 10 ranked FCMs for clearing OTC swaps (both IRS and CDS) from January 2014–March 2016 were: Credit Suisse, Morgan Stanley, Citigroup, JP Morgan, Wells Fargo, Barclays, BOA/Merrill Lynch, Goldman Sachs, UBS, Deutsche Bank (with USB replaced by HSBC in 2015). *See* Clarus Financial Technology (ClarusFT), *FCM League Table Swaps* (2015), https://cdn.clarusft.com/wp-content/upLoads/2016/05/FCM-League-Table-Swaps.png.

[106] *Id*.

[107] *See* CME Group, *What is Clearing?*, https://www.cmegroup.com/education/courses/clearing/what-is-clearing.html.

losses by taking on the positions of [any] defaulted member."[108] Because clearing reduces the risk associated with IRS transactions and streamlines trade processing, it facilitates anonymous all-to-all trading.

118. CFTC regulations implementing the Dodd Frank Act required the clearing of many IRS since early 2013. [redacted][109]

119. Even before clearing became mandatory under Dodd-Frank, a significant volume of IRS trades were already centrally cleared. Many of these trades were inter-dealer trades. A 2007 BIS study determined that, based on LCH.Clearnet SwapClear data, 40% of global interdealer trades were centrally cleared as of December 2006.[110]

D. Dodd-Frank Reforms in the IRS Market

120. The trading platforms that currently operate in the IRS market are governed in relevant part by the following reforms implemented by the Dodd-Frank Act:

121. ***Post-Trade Reporting (2012)*:** Dodd-Frank's post trade reporting mandate became effective on December 31, 2012. This mandate required centralized gathering and reporting of intraday trade data to the public through a SDR.[111] While real-time trade reports provide information about actual price levels and trade sizes, this information only reflects trades that have previously been executed, and thus differs from the pre-trade transparency of willingness to trade, in what size, and at what price that is available in exchange-traded markets such as equities.

122. ***Mandatory Central Clearing (2013)*:** Dodd-Frank's central clearing mandate took effect on March 1, 2013, and applied to the majority of IRS trades.[112] As we saw earlier in Table 1.b of Section II, during the 2013-2017 period, the vast majority of swaps were centrally cleared. Moreover, once the clearing mandate went into effect for U.S. dollar and Euro IRS, the percentage

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[108] *See* LCH.Clearnet, *Central Counterparty Clearing: Federal Reserve Bank of New York 2015 Payment System Policy and Oversight Course* (2015), https://www.newyorkfed.org/medialibrary/media/banking/international/11-LCH-Credit-Risk-2015-Lee.pdf.

[109] *See* [redacted] at p. 17.

[110] Committee on Payment and Settlement Systems ,"New developments in clearing and settlement arrangements for OTC derivatives," *Bank for International Settlements* (2007) pp. 3, 25.

[111] *See* CFTC, *Data Repositories*, https://www.cftc.gov/IndustryOversight/DataRepositories/index.htm.

[112] The clearing mandate was placed on swap dealers, major swap participants and private funds active in the swap market. *See* CFTC, *Release Number 6529-13* (2013), https://www.cftc.gov/PressRoom/PressReleases/pr6529-13.

of cleared notional in all four IRS product categories continued to increase through 2017.

123. ***Mandatory SEF Trading (2014)*:** Since February 2014, IRS that are CFTC-designated MAT IRS must be executed on a SEF or an exchange. If SEF-executed, MAT swaps must be traded via an order book (a real-time electronic list of buy and sell orders, sorted by price) or RFQ provided that the quote request is made to at least three market participants. Swaps that are not MAT-qualified can still trade on-SEF ("Permitted Transactions"), but can be traded using protocols other than RFQ or an order book, and can be executed off-SEF (via voice or a single-dealer non-SEF platform) as well.

124. Currently, and as discussed earlier, only certain types of traditional fixed-floating IRS qualify as MAT swaps.[113] Trades with sufficiently large notional amounts (*i.e.* block trades) as well as package transactions with any non-MAT underlying swaps within the package, are exempted from the SEF trading requirement.[114,115]

E. The IRS Market Remains Bifurcated and Effectively OTC

125. Notwithstanding regulatory developments, buy-side firms' post-2013 IRS trading environment remains similar to the environment prior to 2013: specifically, both environments force bilateral trades and negotiations with IRS dealers on a pre-trade name give-up basis.

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[113] *See* CFTC, *Swaps Made Available to Trade,* http://cftc.gov/PressRoom/PressReleases/ssLINK/swapsmadeavailablechart.

[114] The CFTC has issued a series of No-Action Relief Letters ("NAL") exempting package transactions from SEF trading since the MAT mandate went into effect. *See* CFTC NAL No. 14-12 (February 10, 2014); CFTC NAL No. 15-55 (October 14, 2015); CFTC NAL No. 16-76 (November 1, 2016).

[115] The notional amount specified in an IRS contract may be sufficiently large as to classify the trade as a "block trade." While the terms of a block trade may be similar to non-block trades, the large notional amount of the contract affects how it is treated by regulators. The definition of a block trade is based on notional amounts above certain thresholds that vary by the type of contract, including the currency and tenor. Block trades are not required to trade on SEFs, and they are treated differently under the CFTC mandated real-time reporting requirements (described below). Thus, while block trades can be (and are) executed on SEFs, they can be executed off-SEF if the parties choose. In addition, the transactional records disseminated to the public identify transactions that are block trades, and the reported notional amount is capped in order not to reveal the full notional amount that was traded. Two commonly traded packages are curves and butterfly packages. Both curve and butterfly packages allow investors to take offsetting positions such that the value of the package is a function of the term structure of interest rates but neutral with respect to a shift in interest rates across the tenors comprising the package. A curve package involves an investor taking opposite positions in two fixed-for-floating swaps of different tenors. A butterfly package involves three separate fixed-floating contracts at three tenors, *e.g.*, a 5-year, 10-year, and 30-year swap. The payment direction on the middle tenor swap is the opposite of the shortest and longest tenors.

1. Trading Platforms in the IRS Market During the Class Period

126. ***Dealer-to-Client Platforms*:** From 2013 onward, nearly all buy-side trades were executed via voice, via single-dealer portals, or via two SEFs dedicated to D2C trading: Bloomberg and Tradeweb. [redacted][116]

127. ***Dealer-to-Dealer Platforms*:** [redacted][117] [redacted][118]

128. [redacted][119] During the class period, [redacted][120]

129. Plaintiffs allege that dealers use the practice of post-trade name give-up to deter buy-side firms from trading on the IDB platforms and thereby preserve a bifurcated IRS market.[121] There is economic validity to this allegation. Once IRS are centrally cleared, there is no meaningful market structure driven reason to require post-trade name give up. [redacted]

[116] *See* [redacted] *see also* [redacted]

[117] *See* [redacted]0 at p. 15 ([redacted] at p. 17 ([redacted] at '038 [redacted]

[118] *See* [redacted] at '706.

[119] *Id.* ([redacted] *see also* [redacted] at p. 29 ([redacted]

[120] *See* [redacted] at '201.

[121] *See* Third Consolidated Amended Class Action Complaint, ¶¶ 292-302.

[redacted][122] [redacted][123] [redacted][124] I[redacted][125]

130. ***Anonymous All-to-All Platforms*:** During the class period, in addition to the IDB CLOBs discussed above, four IRS trading platforms offered anonymous all-to-all IRS trading protocols: Javelin, TeraExchange, trueEX, and Bloomberg.[126] [redacted]

[122] Deposition of [redacted] October 16, 2018, 56:22-25; 57:11-61:21; 66:9-25; 68:2-22; 69:2-7; 71:6-9; 222:19-25; 289:20-290:8.

[123] *See* [redacted]2 at '625; *see also* [redacted] at '802 ("[redacted]"); [redacted] at '803 ([redacted]

[124] *See* [redacted] at '174 ([redacted]

[125] *See* [redacted] at '201.

[126] The Javelin SEF Rulebook (2013) describes its CLOB functionality, as well as an anonymous RFQ (*See* Javelin SEF, LLC Rulebook 2013, pp. 43, 45); The trueEX SEF Rulebook operated an anonymous CLOB platform at least by November 18, 2015 (*See* trueEX letter to CFTC "Self-Certification of Rule Amendments (trueEX LLC submission #2015-08D, Appendix A-1, p. 6); According to TeraExchange's Rulebook, it operated an anonymous CLOB in 2013 (*See* TeraExchange, LLC Rulebook, October 2013, p. 34).

[redacted][127] [redacted]

[redacted][128] I further understand that Plaintiffs' counsel have argued that the lack of volume on Bloomberg's CLOB is a direct result of the alleged conspiracy.

2. Evidence that the Alleged Conspiracy Impeded the Evolution of the IRS Market

131. Although I express no opinion on the issue of liability, I note that collectively blocking the development of the IRS market towards an anonymous all-to-all model would be consistent with the economic incentives of the dealers. Defendants' own documents acknowledge [redacted][129] Evidence produced in discovery suggests [redacted]

132. Consistent with the economic incentives I describe above, [redacted] Several documents from Defendants' production illustrate this point:

- [redacted][130]
- [redacted][131]

133. Other evidence I reviewed suggests [redacted]

[127] *See* [redacted]

[128] *See* [redacted]

[129] *See* [redacted] at '539; *see also* [redacted] Ex. [redacted] at p. 8 ([redacted]

[130] *See* [redacted] ([redacted] Ex. [redacted] at '907.

[131] *See* [redacted] ([redacted] Ex. [redacted]) at p. 2.

[redacted] For instance, in April 2013, [redacted] emailed [redacted] to ask [redacted][132] [redacted] wrote back: "[redacted][133] Later that year, [redacted] informed [redacted] that [redacted][134]

134. More broadly, [redacted]) testified that it "[redacted][135]

135. I understand there is also evidence that [redacted] Defendant [redacted] wrote in a 2015 presentation that "[redacted][136]

136. Other evidence suggests that [redacted]

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[132] *See* [redacted] ([redacted] Ex. [redacted]).

[133] *Id.*; *see also* Deposition of [redacted] ([redacted] November 30, 2018, 67:17-68:5 ([redacted]

[134] *See* [redacted] ([redacted] Ex. [redacted]) at '789; [redacted] ([redacted] Ex. [redacted]) at '290 ([redacted] writes internally in December 2012, in response to an email asking "[redacted] *see also* Deposition of [redacted] November 16, 2018, 183:4-8 ("[redacted]

[135] Deposition of [redacted] January 10, 2019, 80:23-84:24.

[136] *See* [redacted], at p. 2; Deposition of [redacted] ([redacted] September 28, 2018, 120:6-9 ("[redacted] Deposition of [redacted] ([redacted]), November 9, 2018, 80:3-10 [redacted] *see also* Deposition of [redacted]), October 10, 2018, 270:13-272:9 ([redacted]

[redacted]:

- As [redacted] wrote in an internal email, "[redacted]."[137]
- With regards to [redacted], in 2012, [redacted] ([redacted]), [redacted][138]
- I have [redacted] seen evidence that Defendants [redacted] and [redacted][139]

137. Although I offer no opinion on the issue of liability, the above-described evidence [redacted]

IV. ALL CLASS MEMBERS WERE IMPACTED BY THE ALLEGED CONSPIRACY

138. This section articulates how class members were harmed by the alleged conspiracy and why this harm was common across the class.

139. *First*, my analysis finds that during the class period, class members paid wider bid-ask spreads and transacted lower volumes of standardized IRS than they would have in the but for world. Standardized IRS instruments would have migrated to anonymous all-to-all platforms but for the Defendants' alleged collusion, as Sections II and III of my report discuss. Although I reach conclusions about these issues independently, my analysis is corroborated and reinforced by the report filed by Professor Duffie in this matter. Professor Duffie concludes that the introduction of anonymous all-to-all trading would have myriad market-wide benefits, including reduced trade execution costs, lower costs for exiting positions with dealers, improved transparency and matching efficiency, lower operational costs, and improved liquidity. As Professor Duffie

[137] *See* [redacted] ([redacted] Ex. [redacted]) at '322.

[138] *See* [redacted] ([redacted] Ex. [redacted]) at '396.

[139] *See* [redacted] at p. 3.

explains, because these are systemic, *market-wide* changes, all class members would benefit from them.

140. *Second*, my independent analysis concludes that bid-ask spreads would have been lower even for transactions in IRS encompassed within the class definition that may not have traded on an anonymous all-to-all platform. I reach this opinion because the bid-ask spreads paid for these IRS would have compressed from market-wide effects, whether they were traded on-SEF or off-SEF. The market-wide effects derive from the greater price competition and transparency and lower spreads associated with the trading of standardized IRS on all-to-all platforms. Economic principles suggest that spreads on such less-standardized IRS would have been disciplined by the incentives of buy-side investors to substitute into on-platform instruments if spreads on off-platform IRS do not experience similar declines in spreads. Likewise, these same spreads would have been disciplined by the entry of competing sources of liquidity into off-platform venues for these less-standardized instruments should off-platform spreads offer relatively greater profit opportunities for supplying IRS liquidity than the platforms for standardized IRS. Thus, both supply and demand forces in less-standardized IRS would work to shrink spreads for less-standardized IRS in the but for world.

141. *Third*, my analysis leads me to conclude that the but for world's lower bid-ask spreads, by making trades cheaper and therefore more attractive, would also have generated greater trading volumes in standardized IRS products than observed in the actual world.

142. *Lastly*, buy-side trading volumes of particular less-standardized IRS could have increased or decreased depending on the degree of substitution between standardized and less-standardized products in moving to the but for world. However, it is my opinion that any volume decrease in less-standardized IRS would be more than offset by volume increases in standardized IRS. The but for world therefore would have generated larger aggregate buy-side trading volume.

143. Thus, on a market-wide basis, class members paid higher bid-ask spreads and traded lower volumes of IRS than they would have if anonymous all-to-all platforms had become established in the IRS market by the beginning of the class period. All or virtually all class members suffered harm due to Defendants' alleged conspiracy, although the precise quantum of damages incurred by each class member could vary.

144. My conclusion that class members suffered common economic harm from the alleged conspiracy derives from my understanding of the academic research literature, evidence

produced in discovery, and data that I analyzed with well-accepted statistical methods. The evidence I reviewed in reaching this conclusion is common to the class and is the type of evidence economists use in research to determine market-wide consequences of market structure.

145. As noted, Plaintiffs allege that Defendants boycotted three SEFs (Javelin, TeraExchange, and trueEX) and also conspired to maintain name give-up on IDBs, effectively preventing the IDBs from opening their platforms to the buy side. Plaintiffs also allege that Defendants collectively agreed to impede and not use Bloomberg's CLOB. Ultimately, the opinions expressed above do not hinge on the specific details of how anonymous all-to-all trading would have been distributed across these or other competing platforms. It does not matter, for example, whether the aforementioned SEFs would have succeeded with anonymous all-to-all platform structures in the but for world. Under virtually any set of circumstances, for reasons detailed in Professor Duffie's report, the emergence of one or more anonymous all-to-all platforms would have benefitted class members in the ways described below.

A. The Class Incurred Wider Spreads on Standardized IRS Suitable for Trading on Anonymous All-to-All Platforms

146. As Section II discusses, a substantial share of all IRS trading involves standardized IRS. These instruments are well-suited to being traded on anonymous all-to-all platforms. New financial markets succeed by attracting sufficient liquidity provision in their early stages to entice buy-side entities or other liquidity-seeking dealers to the platform and, in turn, to incentivize additional liquidity suppliers to compete on the platform, driving down trading costs. The allegedly collusive boycott of such platforms by Defendants prevented such markets from taking root by withholding the critical mass of liquidity required to drive the virtuous cycle of buy-side participation, furthering competition in liquidity supply and market growth.[140] Absent the alleged conspiracy, such platforms would have emerged no later than the beginning of the class period to compete with existing market venues for the trading of standardized IRS. Such all-to-all platforms allow for liquidity to be supplied, not just by Defendants, but by any entity that posts limit and market orders anonymously on an all-to-all platform and is willing to provide a quote on request. The resulting competition for liquidity (or market-making activity) would reduce the bid-ask spreads charged for transactions of such standardized IRS and enable significantly higher buy-side

[140] As [redacted] testified, "[redacted]." Deposition of [redacted] ([redacted]), February 6, 2019, 82:18-82:20.

trading volumes in these IRS. In Section IV.B, I further explain how the transparency, substitution, and migration associated with lower bid-ask spreads for standardized IRS would also impact IRS that would not trade on an anonymous all-to-all platform, lowering their bid-ask spreads. The lowering of bid-ask spreads for all IRS is the primary impact of the alleged conspiracy that can be quantified. The bid-ask spread shrinkage, and the class-wide economic loss attached to that shrinkage, can be reliably measured, as Section V shows.

1. Transparency Breeds Lower Spreads

147. In the but for world, bid-ask spreads of standardized IRS would compress, not only from having multiple liquidity suppliers, but also because of greater transparency. Investors would have enjoyed a larger range and depth of market quotes both before making a trading decision (pre-trade transparency) and from disclosure of the terms of specific transactions after they occur (post-trade transparency). This transparency depends not just on the specificity with which information is observed but also the speed with which it becomes available.[141] The pre-trade transparency provided by a CLOB—with its continual stream of prices and expressions of willingness to trade—certainly exceeds the pace and opaqueness of OTC and RFQ, which are relatively dark pre-trade. Post-trade transparency is not only a function of the trade frequency and size, but also of how close transacted prices are to fair value. With lower bid-ask spreads, transacted prices are closer to fair value by definition.

2. Empirical Finance Evidence on the Extent of Spread Compression from Transparent Platforms

148. Empirical research from multiple financial markets confirms that bid-ask spreads shrink when the trading of financial instruments migrate to more transparent and more competitive platforms. There are many examples of this migration. Treasury bonds migrated from voice-

[141] Flood, Mark D., Ronal Huisman, Kees G. Koedijk, Ronald J. Mahie, "Quote Disclosure and Price Discovery in Multiple-Dealer Financial Markets," *The Review of Financial Studies*, Vol. 12, No. 1 (1999). The authors provide experimental evidence that pre-trade transparency reduces bid-ask spreads. As they note: "Pretrade transparency significantly reduces search costs, thus alleviating some uncertainty and facilitating trade. As a result, market liquidity, measured by spreads and volume, is greater in the transparent market: opening spreads are smaller and interdealer trading volume is much higher." *Id.* at p. 57.

assisted networks to electronic platforms with the introduction of such platforms in 1999.[142] Corporate bond trading increasingly moved to electronic platforms and underwent reforms starting in 2002 that enhanced post-trade transparency.[143] Dividend swaps migrated from being OTC-traded to exchange-traded in 2008.[144] Stock index futures migrated from open outcry to electronic exchanges in London, Sydney and Hong Kong in 1999-2000.[145] German government bond futures and MSCI Taiwan futures transitioned from open outcry to electronic trading in 1997 and 2005, respectively.[146] Commodity futures markets, previously open outcry markets, introduced electronic trading and enabled a significant increase in market competition.[147] Migration of equities trading on NYSE and Nasdaq to electronic communication networks (ECN) took place starting in 1997.[148] The CLOB on NYSE was opened to off-the-exchange-floor market participants in 2002.[149] Nasdaq traders obtained access to the depth of the CLOB with the

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[142] Mizrach, Bruce and Christopher Neely, "The Transition to Electronic Communications Networks in the Secondary Treasury Market," *Federal Reserve Bank of St. Louis Review* Vol. 88, No. 6 (November/December 2006), pp. 527-531, 536-539.

[143] Bessembinder, Hendrik, William Maxwell and Kumar Venkataraman, "Market Transparency, Liquidity Externalities, And Institutional Trading Costs in Corporate Bonds," *Journal of Financial Economics*, Vol. 82 (2006), pp. 251-288; Edwards, Amy K., Lawrence E. Harris, and Michael S. Piwowar, "Corporate Bond Market Transaction Costs and Transparency," *The Journal of Finance*, Vol. LXII, No. 3 (June 2007), pp. 1421, 1438, 1446, 1447, 1448; Goldstein, Michael A., Edith S. Hotchkiss and Erik R. Sirri, "Transparency and Liquidity: A Controlled Experiment on Corporate Bonds," *The Review of Financial Studies* Vol. 20, No. 2 (2007), pp. 235-273.

[144] Abouhossein, Kian; Lee, Delphine; and Leech, Cormac, "Regulatory Proposal Analysis: Structural IB Profitability Decline," JPMorgan, September 9, 2009 at p. 57

[145] Aitken, M. J., et al., "The Impact of Electronic Trading on Bid-Ask Spreads: Evidence from Futures Markets in Hong Kong, London, and Sydney," *The Journal of Futures Markets*, Vol. 24, No. 7 (July 2004), pp. 675-696.

[146] Frino, Alex, Thomas H. McInish, and Martin Toner "The liquidity of automated exchanges: new evidence from German Bund futures", *Journal of International Financial Markets, Institutions and Money*, Vol. 8 (1998), pp. 225-241; Chun-An Li and Hung-ChengLai, "The impact of the trading systems development on bid-ask spreads," *Investment Management and Financial Innovations*, Vol. 5, Issue 1, 2008, pp. 51-56.

[147] Raman, Vikas, Michel A. Robe and Pradeep K. Yadav, "The Third Dimension of Financialization: Electronification, Intraday Institutional Trading, and Commodity Market Quality," November 2017, Research Paper, Office of the Chief Economist, U.S. Commodity Futures Trading Commission, accessed at https://www.cftc.gov/About/EconomicAnalysis/ResearchPapers/index.htm.

[148] McAndrews, James, and Chris Stefanadis, "The Emergence of Electronic Communications Networks in the U.S. Equity Markets," Federal Reserve Bank of New York, *Current Issues in Economics and Finance*, Vol. 6 No. 12 (October 2000).

[149] Boehmer, Ekkehart, Gideon Saar, and Lei Yu, "Lifting the Veil: An Analysis of Pre-trade Transparency at the NYSE," *The Journal of Finance*, Vol. LX, No. 2 (April 2005), pp. 783-815.

introduction of SuperMontage in 2002.[150] I discuss the empirical evidence on how these transformations affected bid-ask spreads next.

a. Treasury and Corporate Bonds

149. Like OTC swaps, Treasury and corporate bonds are traded in large volumes, predominantly by institutional investors. Unlike the IRS market, the Treasury and corporate bond markets underwent structural changes that introduced significantly greater transparency and competition to the trading process.

150. As of 1999, the interdealer market for Treasury securities was predominantly a voice-brokered market, with electronic screens displaying indicative dealer quotes that served only to initiate voice negotiations.[151] In 1999, taking advantage of the relatively homogenous nature of Treasuries, Cantor Fitzgerald launched the first electronic trading platform for these securities, in which dealers could post, or strike against, executable quotes of other market participants. Within a year, a consortium of dealers, including Goldman Sachs and Morgan Stanley, launched a competing electronic platform called BrokerTec. The subsequent competition between these platforms and the enhanced competitiveness of trading Treasuries caused the spreads on Treasuries to compress by 75% to 82% by 2004.[152]

151. The rate of spread compression documented through 2004 occurred even before the Treasury market was exposed to competition from the high frequency trading firms ("HFTs") and principal trading firms ("PTFs") that have subsequently become major suppliers of liquidity in this market. In its early days, BrokerTec remained an inter-dealer market in which dealers faced competition from other dealers in supplying liquidity. Starting in 2004, BrokerTec opened access to platform to a wider group of non-dealer liquidity providers such as PTFs and HFTs. In addition, BrokerTec provided both pre- and post-trade anonymity for those who were able to participate on the platform.[153] PTFs and HFTs were able to exploit this trading structure and the growing

[150] Chung, Kee H., and Chairat Chuwonganant, "Transparency and market quality: Evidence from SuperMontage," *Journal of Financial Intermediation* 18 (2009).

[151] The electronification of interdealer Treasury markets is documented by Mizrach, Bruce and Christopher Neely, "The Transition to Electronic Communications Networks in the Secondary Treasury Market," *Federal Reserve Bank of St. Louis Review*, Vol. 88, No. 6 (November/December 2006), pp. 527-541.

[152] *Id.* at p. 538.

[153] *Id.*

sophistication of electronic trading technology to compete effectively in liquidity supply.[154] As a result, HFTs accounted for over 50% of volume in certain Treasury instruments by October 2014, with bank-dealers accounting for less than 35%.[155]

152. Even before recent market developments made electronic all-to-all trading more prevalent, corporate bonds traded on two alternative venues in the United States, with different levels of transparency: the New York Stock Exchange and the OTC market. Chen and Zhong (2012) compare bid-ask spreads of bonds that trade both on the New-York Stock Exchange and OTC, and bonds that trade only OTC.[156] This study evaluates the effects of improvement in pre-trade transparency, which is substantially better for NYSE-traded bonds than for bonds traded only OTC. The authors state: "[T]he test group [NYSE-traded bonds] has on average 25 basis points smaller effective bid-ask spreads than the control group [bonds traded OTC only]. The finding is consistent across different rating categories."[157]

153. The introduction of the MarketAxess platform brought electronic all-to-all trading to the market for corporate bonds. A [redacted] analyst report [redacted] [158] That study also finds that [redacted] The report states:

> "[redacted]

[154] Bech, M., Anamaria Iles, Ulf Lewrick and Andreas Schrimpf, "Hanging up the phone – electronic trading in fixed income markets and its implications," Bank of International Settlements Quarterly Review, March 2016, pp. 79-94.

[155] Joint Staff Report, The U.S. Treasury Market on October 15, 2014, U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, U.S. Commodity Futures Trading Commission, Table 3.3.

[156] Fan Chen and Zhuo Zhong, "Pre-trade Transparency in Over-the-Counter Markets," Working Paper (August 2012).

[157] *Id.* at p. 3.

[158] [redacted], October 4, 2012, [redacted].

[redacted]"[159]

154. In a well-known academic research paper, Hendershott and Madhavan (2015) document that in the electronic market for corporate bonds, transaction costs decline rapidly as the number of responding dealers in electronic auctions increases. Based on this result the authors state that "[c]ompetition lowers costs." Their findings further suggest that the continuous auction trading that characterizes all-to-all trading on an exchange (such as, *e.g.*, NYSE) results in lower transaction costs for investors.[160]

155. Other reforms in the trading of US corporate bonds, which preceded the MarketAxess platform, already served to bring greater post-trade transparency to the corporate bond market. Bessembinder et al. (2006), Edwards et al. (2007) and Goldstein et al. (2006) analyzed the effect on bid-ask spreads from the introduction of mandatory reporting of trade prices for U.S. corporate bonds under the Trade Reporting and Compliance Engine ("TRACE"), which started in 2002-2003.[161] All three articles find that the increased level of post-trade transparency stemming from the introduction of TRACE drove down bid-ask spreads. The articles state: "estimated reductions in trading costs average 40–60% of pre-TRACE trading cost estimates,"[162] and that "[c]osts are lower for bonds with transparent trade prices, and they drop when the TRACE system starts to publicly disseminate their prices. The results suggest that public traders benefit significantly from price transparency…."[163] and "[t]he decrease in transaction costs for such trades is consistent with investors' ability to negotiate better terms of trade with dealers once the investors

[159] *Id.* at p. 16.

[160] Hendershott, Terrence, and Madhavan, Ananth, "Click or Call? Auction versus Search in the Over-the-Counter Markets," *The Journal of Finance*, Vol. 70, No. 1 (February 2015), p. 441.

[161] Bessembinder, Hendrik, William Maxwell and Kumar Venkataraman, "Market Transparency, Liquidity Externalities, And Institutional Trading Costs in Corporate Bonds," *Journal of Financial Economics*, Vol. 82 (2006), p. 251-288; Edwards, Amy K., Lawrence E. Harris, and Michael S. Piwowar, "Corporate Bond Market Transaction Costs and Transparency," *The Journal of Finance*, Vol. LXII, No. 3 (June 2007), pp. 1421, 1438, 1446, 1447, 1448; Goldstein, Michael A., Edith S. Hotchkiss and Erik R. Sirri, "Transparency and Liquidity: A Controlled Experiment on Corporate Bonds," *The Review of Financial Studies*, Vol. 20, No. 2 (2007), pp. 235-273.

[162] Bessembinder, Hendrik, William Maxwell and Kumar Venkataraman, "Market Transparency, Liquidity Externalities, and Institutional Trading Costs in Corporate Bonds," *Journal of Financial Economics*, Vol. 82 (2006), p. 253.

[163] Edwards, Amy K., Lawrence E. Harris, and Michael S. Piwowar, "Corporate Bond Market Transaction Costs and Transparency," *The Journal of Finance*, Vol. 62, No. 3 (June 2007), pp. 1421, 1438, 1446, 1447, 1448.

have access to broader bond-pricing data."[164]

156. Similar results have been documented for the trading of European corporate bonds. When examining pricing and competition in the European bond market, Biais and Declerk (2013) found that increased dealer concentration is associated with larger bid-ask spreads. Specifically, they found that spreads increased with dealers' market power. Their regression analysis, controlling for other variables, estimated the difference in effective spreads between bonds for which the market share of the most active dealers was above 40% and other bonds. They found that, in 2003, such market power raised the effective spread by 5.6 bps for a bond price of €100. In 2004 and 2005 the corresponding figures were .45 bps and 1.63 bps.[165]

b. Futures

157. Futures and equity markets have also undergone the kinds of changes that bring greater competition and transparency.

158. Raman, Robe and Yadav (2017) examine how the introduction of electronic trading affected liquidity and bid-ask spreads in commodity futures markets. They focus on a "major structural change" in the trading of West Texas Intermediate ("WTI") light sweet crude oil futures, one of the world's most active energy derivatives, starting on September 5, 2006, when the New York Mercantile Exchange ("NYMEX") first allowed electronic trading on the Globex platform alongside open outcry trading in NYMEX's pits.[166] The authors note that the introduction of electronic trading brought about a "transformative easing of access from traders without access to the pits," which allowed these traders to compete effectively with market-makers (or "locals") in open outcry pits to supply liquidity.[167] Using non-public, trader-level data made available by the U.S. Commodity Futures Trading Commission ("CFTC"), the authors examined how this

[164] Goldstein, Michael A., Edith S. Hotchkiss and Erik R. Sirri, "Transparency and Liquidity: A Controlled Experiment on Corporate Bonds," *The Society for Financial Studies* (Oxford University Press July 1, 2006), pp. 269-270.

[165] Biais, Bruno and Fany Delclerk, "Liquidity, Competition and Price Discovery in the European Corporate Bond Market," Toulouse School of Economics, Working Paper (February 2013), p. 4.

[166] Raman, Vikas, Michel A. Robe and Pradeep K. Yadav, "The Third Dimension of Financialization: Electronification, Intraday Institutional Trading, and Commodity Market Quality," November 2017, Research Paper, Office of the Chief Economist, U.S. Commodity Futures Trading Commission, accessed at https://www.cftc.gov/About/EconomicAnalysis/ResearchPapers/index.htm.

[167] *Id.* at Introduction.

electronification affected measures of market liquidity for WTI futures, including bid-ask spreads. The authors compared these liquidity measures between a "Pre-Electronification" period from January 3, 2006 to September 1, 2006 and a "Post-Electronification" period from September 6, 2006 to May 31, 2008. They found that estimated bid-ask spreads for WTI futures dropped by nearly 92% from Pre-Electronification to Post-Electronification.[168] Moreover, substantially all of this decline occurred shortly after the electronification, with bid-ask spreads reaching their new lower level before November 2006.[169]

159. Aitken et al. (2004) analyze the transition of stock index futures from the open outcry (or floor) exchange trading to more transparent electronic trading on three exchanges: the London International Financial Futures and Options Exchange; the Sydney Futures Exchange; and the Hong Kong Futures Exchange, during 1999-2000. The authors provide "evidence of a decrease in bid-ask spreads following the introduction of electronic trading, after controlling for changes in price volatility and trading volume." The article finds "support for the proposition that electronic trading can facilitate higher levels of liquidity and lower transaction costs relative to floor traded markets."[170]

160. Chun-An Li and Lai (2008) analyze the introduction of electronic trading in MSCI Taiwan futures on the Singapore stock exchange.[171] Prior to June 26, 2000, the futures traded on the exchange floor (open outcry) only. Between June 26, 2000 and July 1, 2005, the open outcry and more transparent electronic trading co-existed, while after July 1, 2005, only electronic trading was available. The article concluded that bid-ask spreads were lower on the electronic platform than on the exchange floor during the period when the futures traded simultaneously on the floor and electronically. Moreover, bid-ask spreads in the first 50 days of fully electronic trading starting July 2005 were nearly 80% lower than the spreads that prevailed in the 50 days before the initial introduction of electronic trading in June 2000.[172]

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[168] *Id.* at Section 4.1 and Table 1.

[169] *Id.* at Figure 1.

[170] Aitken, Michael J., et al., "The impact of electronic trading on Bid-Ask Spreads: Evidence from futures markets in Hong Kong, London, and Sydney," *Journal of Futures Markets*, Vol. 24, No. 7 (July 2004), pp. 676, 678-696.

[171] Li, Chun-An, and Lai, Hung-Cheng, "The impact of the trading systems development on bid-ask spreads," *Investment Management and Financial Innovations*, Vol. 5, issue 1 (2008), p. 56.

[172] Li, Chun-An, and Lai, Hung-Cheng (2008), Table 3.

161. Frino et al. (1998) and Pirrong (1996) compare bid-ask spreads of German government bond futures traded on Deutsche Terminborse (DTB), an electronic exchange, and LIFFE (open outcry). The authors conclude that a higher level of transparency on DTB results in lower spreads and/or higher liquidity on that exchange compared to LIFFE.[173]

c. Equities

162. Numerous studies analyze the effects of changes in equity market transparency on bid-ask spreads and other metrics of market quality and liquidity.[174] Virtually all indicate that bid-ask spreads declined following the improvements in pre-trade transparency. For example, in a natural experiment, when the SEC Rule 605 required public disclosure of execution quality in phases, spreads substantially declined for those stocks with enhanced transparency.[175] Researchers who analyzed this event found that "the average effective and quoted spreads declined by more than one and two cents, respectively, after implementation of the Rule. In relative terms, these figures are equivalent to more than a 20% reduction in spreads."[176]

163. In a study of the effects of increased competition and transparency, not tied to

[173] Frino, Alex, et al. "The liquidity of automated exchanges: new evidence from German Bund futures", *Journal of International Financial Markets, Institutions and Money*, Vol. 8, Issue 3-4 (December 1998), p. 225–241; Pirrong, Craig, "Market Liquidity and Depth on Computerized and Open Outcry Trading Systems: A Compression of DTB and LIFFE Bund Contracts", *The Journal of Futures Markets*, Vol. 16, No. 5 (August 1996), pp. 519-543.

[174] Equity studies of pre-trade transparency with expanded dissemination of the limit order book have looked at (i) the NYSE's OpenBook service that provides limit-order book information to traders off the exchange floor; (ii) NASDAQ's SuperMontage, an integrated order display and execution system; (iii) Island ECN's "going dark'' by no longer displaying its automated limit order book to any market participant and later reversing its decision; (iv) the Korea Stock Exchange's Disclosure of the best buy and sell prices and the number of shares desired or offered at those prices; (v) the Taiwan Stock Exchange's dissemination of the five best bid and ask prices; (vi) the Tokyo Stock Exchange's tripling of the number of quotes disclosed; (vii) disclosures of execution quality in the US prompted by the SEC Rule 605. *See* Boehmer, Ekkehart, et al., "Lifting the Veil: An Analysis of Pre-trade Transparency at the NYSE," *The Journal of Finance*, Vol. 60, No. 2 (April 2005), pp. 783-815; Kee, Chung H., and Chuwonganant, Chairat, "Transparency and market quality: Evidence from SuperMontage," *Journal of Financial Intermediation*, Vol. 18 (2009), pp. 93, 94, 99, 101, 102; Hendershott, Terrence and Jones, Charles M., "Island Goes Dark: Transparency, Fragmentation, and Regulation." The Review of Financial Studies, Vol. 18, No. 3, 2005, pp. 743-793; Eom, Kyong S., et al., "Pre-trade transparency and market quality," *Journal of Financial Markets*, Vol. 10, No. 4 (November 2007), pp. 319-341; Ke, Mei-Chu, et al., "The impact of transparency on market quality for the Taiwan Stock Exchange," *International Review of Economics and Finance*, Vol. 27 (2013), pp. 330, 332, 334, 335, 336, 337; Sakawa, Hideaki and Ubukata, Masato, "Does Pre-trade Transparency Affect Market Quality in the Tokyo Stock Exchange?" Economics Bulletin (2012), p. 2110

[175] Zhao, Xin, and Chung, Kee H., "Information Disclosure and Market Quality: The Effect of SEC Rule 605 on Trading Costs," *Journal of Financial and Quantitative Analysis*, Vol. 42, No. 3 (September 2007), pp. 657-682.

[176] *Id.* at p. 681.

specific events or structural changes, Fink, Fink, and Weston (2006) find that the increased market share of ECNs in NASDAQ between 1996 and 2002 was associated with significant decreases in bid-ask spreads.[177] The authors state: "We find that the development of these alternative trading platforms is associated with tighter quoted, effective, and relative bid–ask spreads, greater depths, and less concentrated markets."[178]

164. An episode of decreased transparency had the opposite effect of increasing bid-ask spreads at the Island ECN. As part of the implementation of Regulation ATS in 1998, the SEC required Island ECN on September 23, 2002 to comply with certain display requirements in several of its highest volume ETFs, where Island dominated trading and price discovery. Island chose to comply by going "dark", no longer displaying its limit order book.[179] The authors of a published study analyzing this event found that when Island goes dark, "both Island trading costs and overall ETF trading costs rise…. Island liquidity providers earn more…, [which] indicates a reduction in competition within Island…. Island's effective spreads double in DIA and QQQ and go up by 50% in SPY after going dark…."[180]

d. Other Markets

165. Dividend swaps allow the purchaser of the swap to pay a fixed dividend amount at expiry in exchange for all actual qualifying dividends on the underlying stock or index during the life of the swap.[181] Originally created in 1990 to enable dividend trading, dividend swaps remained an over-the-counter financial product until Eurex created listed dividend futures as an alternative to dividend swaps in June 2008. Following this exchange listing, bid-ask spreads on dividend swaps decreased from 4 basis points to 1, a decline of 75%.[182]

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[177] Fink, Jason; Fink, Kristin E.; and Weston, James P., "Competition on the Nasdaq and the Growth of Electronic Communication Networks," *Journal of Banking & Finance*, Vol. 30, 2006, pp. 2537-2559.

[178] *Id.*at p. 2537

[179] Hendershott, Terrence and Jones, Charles M., "Island Goes Dark: Transparency, Fragmentation, and Regulation." The Review of Financial Studies, Vol. 18, No. 3, 2005, pp. 743-793.

[180] *Id.* at p. 770.

[181] Bennett, Colin; Barbereau, Fabrice; Joubert, Arnaud; Gupta, Anshul; Favresse, Jerome; and Fardoun, Ali, "Dividend Swaps and Dividend Futures: A Guide to Index and Single Stock Dividend Trading," Barclays Capital, October 11, 2010

[182] Abouhossein, Kian; Ranjan, Amit; Kantarovich, Alex; Lee, Delphine; Klaczek, Josh; Francois, Nana; Bilandani, Naresh; Tsujino, Natsumu; Sinha, Raul; Martinez, Saul; Manning, Scott; Sen, Seshadri K.; Peterzens, Sofie; Gautam, Vivek; and Juneja, Vivek, "Can Universal Banking Model Survive the New Wave of Uncoordinated IB Regulations? OW Tier II IBs," JPMorgan, April 11, 2013 at p. 73

166. In summary, the studies above all support the conclusion that bid-ask spreads shrink significantly when the emergence of new trading mechanisms create greater competition for market-making and bring greater transparency to the pricing of financial instruments. By its nature, this spread compression is a *market-wide* phenomenon that benefits all buy-side market participants. Put another way, spread compression does not depend on the size or identity of an investor/market participant, a particular trading strategy, or the specific product transacted.

3. Dealer Defendant Evidence on Spread Compression

167. Consistent with the transition of these other markets and widely accepted economic principles, numerous contemporaneous documents produced in discovery indicate that [redacted]. Illustrative examples include:

- A July 2007 [redacted] presentation, "[redacted]" specifically addresses "[redacted]" including "[redacted]," and "[redacted]" The presentation also notes that [redacted]."[183]
- An April 2010 [redacted] strategy document stated that: "[redacted]" The document further stated that: "[redacted]

[183] *See* [redacted] at p. 6; [redacted] ([redacted]) testified that one of the "[redacted]" He further explained [redacted]:

[redacted]

Deposition of [redacted] ([redacted]), January 8, 2019, 76:17-78:13.

[redacted]).”[184]

- An August 2010 [redacted] document showed [redacted][185] that if “[redacted]” and “[redacted].”[186]
- A February 2011 presentation prepared by [redacted] (and produced by [redacted]) predicted: “[redacted]”[187]
- An April 2011 [redacted] presentation stated that there would be a “[redacted]” The presentation [redacted]: “[redacted][188]
- A June 2011 analysis prepared for [redacted] estimated that “[redacted][189] [redacted]).
- A February 16, 2012 email from [redacted] stated: “[redacted].”[190]
- A May 2012 [redacted] analyst report described [redacted]

[184] *See* [redacted] ([redacted] Ex. [redacted]) at p. 10.

[185] [redacted] “[redacted]–[redacted],” August 23, 2010, [redacted] at pp. 24–25.

[186] *Id.* at p. 25.

[187] [redacted] “[redacted]” February 2010, [redacted] at ‘525.

[188] [redacted] “[redacted],” April 2011, [redacted] at p. 14.

[189] *See* [redacted] ([redacted] Ex. [redacted] at p. 8.

[190] March 19, 2012 email from [redacted] to [redacted], [redacted] at ‘403.

[redacted]."[191] The report stated the effect would be to sharpen dealers' focus on price competition. Second, [redacted]." [192] [redacted] Third, [redacted]."[193] Fourth, [redacted][194]

- In a June 2013 [redacted] internal email, a [redacted] employee wrote: "[redacted]."[195]
- A July 2013 [redacted] presentation [redacted] The [redacted][196]
- A November 2013 [redacted] presentation stated: "[redacted][197]

168. The [redacted] analyst report cited above [redacted] Table 2 below reproduces a figure from the [redacted] analyst report, [redacted]

[191] [redacted] May 2012, [redacted] at '229.

[192] *Id.* at '293.

[193] *Id.* at '230, '292.

[194] *Id.* at '294.

[195] June 26, 2013 Email from [redacted] to [redacted] at '607.

[196] [redacted], "[redacted] July 2013, [redacted] at p. 1.

[197] [redacted] "[redacted] November 2013, [redacted] at p. 3.

Table 2

Source: at '201

169. Documents and testimony I reviewed in this matter indicate that Defendants concur with my opinion, as well as the view expressed in the academic research literature,

For example:

- testified: "[198] [199]
- at his deposition that " testified: "[200]
- A 2009 report concluded, "

[198] Deposition of December 13, 2018, 28:17-19.

[199] *Id.* at 23:23-25, 24:1-4.

[200] Deposition of September 26, 2018, 107:10-109:25.

[redacted][201] Referring to [redacted] stated: "[redacted][202]

170. This testimony and these documents reflect a basic economic principle: that shifting from OTC trading to anonymous all-to-all trading shrinks bid-ask spreads for all participants in IRS.

4. Lower Search Costs Breed Tighter Spreads

171. A substantial body of finance research examines the relationship between the level of financial markets' competition and bid-ask spreads. Virtually all, if not all, of this literature concludes that increased competition—driven, for example, by the emergence of anonymous all-to-all trading venues alongside the traditional dealers—leads to lower bid-ask spreads across a wide range of financial instruments and markets.

172. In one important market structure paper, Duffie, Garleanu and Pederson (2005) constructed a theoretical model and applied it to several securities markets, including OTC securities markets. Their peer-reviewed article, appearing in one of the leading economics journals, represents one of the most cited papers in economics for its vintage, garnering almost 1,000 Google Scholar citations. The model demonstrates that bid-ask spreads fall as investors' access to market makers increases.

> "Bid-ask spreads are lower if investors can more easily find other investors or have easier access to multiple marketmakers. … An investor … improves his bargaining position relative to a marketmaker if he can more easily find other marketmakers."[203]

As the paper notes:

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[201] [redacted] and [redacted] "[redacted] October 20, 2009, [redacted] at '217.

[202] *Id.* at '222 and '224.

[203] Duffie, Darrell, Nicolae Gârleanu, and Lasse Heje Pedersen, "Over-the-Counter Markets," *Econometrica*, Vol. 73, No. 6 (November 2005), pp. 1815, 1816-1817.

> "An investor's bargaining position depends on his outside option, which in turn depends on the availability of other counterparties, both now and in the future[.]"[204]

173. The emergence of anonymous all-to-all trading venues expands the number of potential liquidity-suppliers for standardized IRS, creating more "outside options" for buy-side investors seeking liquidity and reducing the bargaining power of dealers. Thus, simply by providing more opportunities to trade with other investors, all-to-all platforms lead to lower investor bid-ask spreads. Consistent with this economic conclusion, a 2012 presentation by [redacted] produced in this case [redacted][205]

174. Allowing buy-side investors to search and execute trades without disclosing their identities also reduces their bid-ask spreads. Peer-reviewed studies have shown that anonymity benefits traders through lower bid-ask spreads. In a paper appearing in one of the top three journals in financial economics, Foucault et al. (2003) analyzed a change in identity disclosure rules on a centralized exchange that enhanced anonymity. The Paris Bourse implemented a rule change that allowed traders to stream quotes anonymously, whereas previously their identities were visible on the limit order book. After the rule change took effect, the authors found "the quoted spread and effective spread for the stocks in our sample are significantly smaller after the switch to anonymity."[206]

5. Evidence of Increased Trading Volume

175. The alleged conspiracy also reduced the overall trading volume of IRS as well as the trading volume of class members. Since trades are executed because they are beneficial, trade deterrence harms class members. The improved volume (liquidity) that would be obtained in a market with anonymous all-to-all trading as an option is a benefit that would be enjoyed market-wide, and hence, also across all members of the proposed class, regardless of their reasons for

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[204] *Id.* at p. 1820.

[205] [redacted] at p. 6.

[206] *See* Foucault, Thierry, Sophie Moinas, Erik Theissen "Does anonymity matter in electronic limit order markets?" *The Review of Financial Studies*, Vol. 20, No. 5, 2003, p. 1709; *see also* Carol Osler, Geir Bjonnes, and Neophytos Kathitziotis, "Bid-Ask Spreads in OTC Markets", 2016, Working Paper, p. 13, who find that multibank platforms with anonymous trading similar to electronic limit-order books lower bid-ask spreads.

trading IRS. In the equities market, for example, the spread compression came from changes in market structure, including regulation, decimalization, and technological advances in electronic trading.

176. A bifurcated market structure in which the major IRS dealers are on (at least) one side of trades in both markets inherently reduces liquidity because it prevents the buy side from acting with each other or as market makers. In short, larger networks directly breed more trades. And because spreads are wider, which makes trades cost more in such bifurcated markets, class members will transact less than they would in a market with lower spreads. As spreads compress, trading becomes more efficient and less expensive, driving volumes up.

177. Discovery in this matter indicates that at least certain of the Defendants recognized that trading would significantly increase volume. As noted above, [redacted] testified to this proposition at his deposition. As another example, [redacted] stated that a shift to more transparent and competitive trading venues could increase volumes by up to 373% (*see* ¶ 170 and Table 2, above). A 2011 [redacted] presentation entitled "[redacted]."[207]

178. The additional trading volume that buy-side entities would have realized from the trading of standardized IRS on anonymous all-to-all venues are likely to have generated significant economic benefits for these entities. My methodology for computing damages does not directly calculate the economic harm attached to these related consequences, as it does for the direct damages from excessive bid-ask spreads. However, it should be noted that the economic harm from these additional channels also had a common economic impact for members across the entire class.

B. The Class Also Incurred Wider Spreads on Instruments that May Not Have Traded on Anonymous All-to-All Platforms

179. As Section II observes, certain IRS transactions during the class period involved less standardized contract specifications that might attract limited trading interest on an all-to-all

[207] [redacted] "[redacted] March 2011, [redacted] at '395, '399.

platform. Even for standardized IRS that trade actively on all-to-all platforms, certain transactions such as large (or "block") trades may be conducted outside these platforms. For example, in the actual world, buy-side entities executed some block trades for highly standardized IRS, including MAT IRS, in off-SEF transactions, although a [redacted]

180. Even if an IRS transaction in the actual world involved a swap that was not suited for anonymous all-to-all platform trading, or was conducted at a size that would inhibit execution on an all-to-all platform, these transactions would have directly benefited from the spread compression and transparency created by anonymous all-to-all platforms. There are both demand and supply factors that would lead to tighter bid-ask spreads for these transactions. The demand factors include better information about the true values of IRS and the buy-side investor's ability to substitute into standardized IRS now trading at significantly lower spreads. The supply factors include greater competition between liquidity providers and stronger incentives for liquidity-providers to devote greater resources for off-platform transactions as spreads compress on platform transactions.

181. It is useful to place these sources of spread compression into two categories, depending upon how the class member would have traded in the but for world. The first source, arising from both the demand and supply sides, are the "market-wide benefits" caused by platform trading even for transactions that remain off-platform, reducing their bid-ask spreads through better information about true IRS values and greater competition among liquidity providers for these transactions. The second source, arising on the demand side of the market, is the potential for "product substitution;" *i.e.*, that certain investors can substitute away from an instrument unsuited for platform trading to a similar, platform-traded contract that transacts at significantly lower spreads. These factors are discussed in greater detail next. My conclusions in this regard are similar to those reached by Professor Duffie, though I reach my conclusions through my own independent analysis, and based on my own academic and professional expertise with IRS market structure.

1. "Market-Wide Benefits"

182. The first source of "market-wide benefits"—arising on the demand side of the market for liquidity in IRS—comes from better information. All buy-side investors in the but for world, including those trading off-exchange, obtain significantly greater information from the all-

to-all trading platform. That information includes the range of prices (or rates) being quoted by liquidity providers at a given point in time, the depth of notional volume available to be traded at these prices, and the valuation of IRS by other buy-side entities, as evidenced by their limit orders, as well as the prices and notional volumes at which they transact IRS. The lower prices and greater breadth of market information from anonymous all-to-all platforms gives buy-side investors a richer picture of the market's assessment of the off-platform instrument's value. This information helps the off-platform investor more accurately assess if the quote should be rejected as too costly, and lead to inquiry of another dealer. The initial dealer, knowing that the buy-side client is more informed, is disciplined by knowledge that the client is more likely to walk away from the quote because it unfairly gouges the client.

183. A widely cited corporate bond market study documents the collateral benefits of market transparency for all related instruments, including those not directly the subject of the transparency. This study analyzes the effect of introducing TRACE, a reporting system (discussed earlier) that informed market participants of actual transactions executed in corporate bonds eligible for such reporting. All corporate bonds were not eligible for TRACE reporting. However, Bessembinder, Maxwell and Venkataraman (2006) found that the transparency created by TRACE reduced the transaction costs not only of bonds subject to TRACE reporting, but also for bonds that were not subject to TRACE reporting.[208] The authors note that while trade execution costs fell by approximately 50% for bonds eligible for TRACE-reporting, they also fell by 20% for bonds not eligible for TRACE reporting. The authors attributed the transmission of spread compression from TRACE reporting to bonds outside the scope of TRACE to the information provided by TRACE-eligible bonds.[209]

184. The second source of "market-wide benefits" for off-platform transactions arises on the supply side of the market for liquidity in IRS. The factors operating on the supply side of IRS liquidity to tighten spreads for off-platform transactions include both dealers' internal allocations of scarce resources for liquidity provision and competition across firms to supply liquidity. In the but for world, off-platform IRS products become relatively more profitable if their

[208] Bessembinder, Hendrik, William Maxwell and Kumar Venkataraman, "Market Transparency, liquidity externalities, and institutional trading costs in Corporate Bonds," *Journal of Financial Economics*, Vol. 82 (2006), at pp. 252-254.

[209] *Id.* at pp. 254, 271-78, 283.

bid-ask spreads do not decline as much as products destined for on-platform spreads in the but for world. In this case, profit maximizing dealers, as well as the dealers' competitors, will shift liquidity providing resources from on- to off-platform products, and shift the supply curve for off-platform products upward, decreasing the costs charged to consumers for them.

2. Product Substitution

185. The second demand factor is that lower bid-ask spreads in platform products make it more likely that the on-platform product will be more attractive unless the off-platform dealer matches the price reduction observed in moving to the but for world. To illustrate the second benefit, consider block trades in MAT IRS discussed earlier, for which trade concealment was a motivation to transact off-platform at higher cost. The product here is identical whether on or off the platform. The difference in IRS product price across the two trading venues cannot exceed the benefit of trade concealment or the buy-side investor would transact using the lower price platform. In the but for world, the on-platform price is lower, making the platform relatively more attractive unless the off-platform price is also lowered to prevent such migration.

186. Incentives for the buy side to substitute from an off-platform to an on-platform transaction would exist even if the platforms offer trading only in similar (but not identical) instruments. Consider a customized 4.9-year swap traded OTC with single-dealer RFQ both in the actual and but for worlds. If a 5-year swap witnesses a significant drop in bid-ask spreads following the introduction of anonymous all-to-all platforms, some buy-side clients will have an economic incentive to switch to the 5-year swap on the CLOB unless the 4.9-year swap also reduces its bid-ask spread. This shift in the demand curve for the 4.9-year swap will lower its trading costs and help retain buy-side clients at the new, lower equilibrium spreads.

187. In general, an alternative approach by which market participants could respond to the lower trading costs of the standardized contract on an all-to-all platform is through a minor redesign of the off-platform instrument in order to make it compatible with platform trading. Through this redesign, the trading costs of the instrument would again decrease, although through direct competition for liquidity supply once the instrument becomes traded on a platform.

188. In summary, class members were harmed by the alleged conspiracy even on transactions that may not have been executed on anonymous all-to-all platforms because of: (i) the tighter spreads they would have paid on off-platform transactions; and (ii) because of the greater opportunities they would have enjoyed for economically beneficial substitutions or threats

of substitution from their customized swap transactions in the actual world to significantly cheaper standardized swaps in the but for world.

189. The economics of substitution from one swap to another explains why such substitution can create economic benefits in the but for world. For example, consider an investor seeking to hedge payments in a non-standard interest rate that has a high, if imperfect, correlation with the EURIBOR rate. The investor can choose either a perfect hedge with an IRS referencing its non-standard interest rate, at the off-platform bid-ask spreads quoted by dealers, or a strong but imperfect hedge using a platform-traded contract referencing the EURIBOR rate. If the risks associated with the uncovered portion of a EURIBOR hedge are small in relation to differences in bid-ask spreads, it would be rational for this investor to use the cheaper platform-traded contract instead. By lowering the spreads of the standardized swap, the but for world of anonymous all-to-all platform trading will improve the economic alternatives available to all investors considering customized swaps. No investor will be worse off as a result of the tighter spreads on standardized alternatives and those for whom substitution is more feasible under their investment objectives are strictly better off.

190. Evidence produced in discovery [redacted] For example, a 2016 [redacted] presentation entitled "[redacted]" noted the "[redacted] which included: "[redacted]." The same presentation noted that for "[redacted][210] Notably, [redacted][211]

191. A 2014 [redacted] strategy document similarly notes that "[redacted] including:

[210] [redacted] "[redacted] at p. 16

[211] [redacted] "[redacted]"

"[redacted][212]

192. The likelihood of "[redacted] is also recognized by a 2013 [redacted] presentation entitled "[redacted] which discusses [redacted] and [redacted] "[redacted][213] In other words, [redacted].

193. In summary, the existence of anonymous all-to-all platforms for standardized IRS would have created economic benefits for buy-side entities on their transactions of all IRS products contained within the class definition, irrespective of whether every single trade was executed on anonymous all-to-all platforms. The alleged conspiracy by Defendants prevented the emergence of such all-to-all platforms and thus damaged all or virtually all members of the class, and did so through the common economic channel of raising transactions costs, lowering volume and liquidity, and limiting opportunities to undertake additional trades in the IRS market.

V. DAMAGES ATTRIBUTABLE TO THE ALLEGED CONSPIRACY CAN BE CALCULATED ON A CLASS-WIDE BASIS USING GENERALIZED EVIDENCE

194. As Section IV discussed, I currently can quantify damages from one source of common economic harm to class members from the alleged conspiracy: having to pay excessively high bid-ask spreads when transacting IRS between 2013 and 2017. These bid-ask spreads exceeded the competitive levels that would have prevailed before the start of and (more relevantly) throughout the class period but for the alleged conspiracy. This section sets forth a methodology for quantifying the spreads paid by class members for IRS in the actual world, the spreads that

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[212] [redacted] "[redacted] at p. 1 (emphasis added).

[213] [redacted] "[redacted]" November 2013, [redacted] at p. 3; *see also id.* at p. 3 ([redacted]

would have prevailed in the "but for" world, and the resulting quantum of damages.

A. The Methodology is Well-Suited to the Data Currently Available as well as Data that Could be Available in the Future.

195. The methodology used here is, in my opinion, the optimal choice for the best data currently available to me that economists typically would employ to estimate class damages from excessive spreads. My statistical analysis focuses on data for IRS transactions conducted through the two major dealer-to-client trading platforms, Bloomberg and Tradeweb. These data record key transactional details such as the execution time, the negotiated rate or price, the notional amount, and the main contractual features of the IRS. Where available, I also use publicly available quote data for certain IRS to measure the spreads paid on class member transactions. For other IRS, I compute the actual spreads paid using a well-accepted methodology that relies only on observed fluctuations in actual rates or prices agreed to in IRS transactions.

196. Currently, I am unable to utilize the requested class period bid and ask quotes issued by Defendants for IRS. While such data are desirable for my analysis, Defendants maintain that they have not retained records of their quotes. I was nonetheless able to identify publicly available quote data for a subset of relevant IRS.

197. My analysis also does not yet incorporate dealer-to-client transactions occurring on venues other than Bloomberg and Tradeweb because transactional data provided by Defendants and by the DTCC, which could in principle identify such transactions, lacks the necessary information to readily reconstruct trades with the precision required to observe bid-ask spreads accurately.[214]

198. Appendix 3 discusses the data produced and its limitations. I continue to analyze the available data and examine sources from the public domain, to supplement the data currently used in my analysis. While I will incorporate this additional data into future damages analysis to the extent feasible, it is possible to calculate conservative and reliable damage estimates, both class-wide and on an individual basis methodology, with the data currently available to me.

199. The model employed by the current methodology is highly flexible and able to

[214] I also received a large volume of transactions data from LCH late in December 2018. Given the volume of this data, the work necessary to reconstruct trading records using this data and the limitations of the time available to complete this report, I have not yet been able to prepare this data for my analysis, but will incorporate it later as appropriate.

incorporate additional data as it becomes available. It is a model for computing the spreads actually paid on each IRS transaction. Using available data, as detailed in this section, I first estimate the model. I then compute damages with a straightforward two-step procedure. First, I use the estimated model to compute the spreads actually paid on transactions by class members during the class period. I then determine the spread compression that would have occurred for these transactions in the but for world with anonymous all-to-all trading. The difference between these actual and but for spreads, *i.e.*, the excess spreads paid on class IRS transactions in the actual world, measures quantifiable damages for all class members, as well as any grouping of them. This methodology can reliably be applied to all class members' four types of in scope IRS transactions and can also be adjusted to reflect any changes in my assumptions or decisions made by the fact-finder or Court.

200. Below, I first outline each step of my methodology for calculating class damages. Subsequent portions of Section V detail each step. Appendix 5 summarizes the well-accepted statistical methods used to implement the analysis.

B. Computing the Damages Arising from Spread Inflation

201. Recall that all IRS transactions contain a payment term that is negotiated with a dealer. Except for MAC swaps, discussed below, this payment term is a fixed rate to be paid on a stipulated notional amount. For traditional fixed-for-floating IRS or OIS, this negotiated rate is the fixed interest rate (or "swap rate") that will be paid by one party in exchange for receiving a designated floating rate from the other over the swap's tenor. For single-currency basis swaps, in which each party pays the other a floating rate, the fixed rate is an additional interest payment (a "rate spread," not to be confused with the dealer's bid-ask spread) one party makes to the other to account for anticipated differences in the levels of these floating rates. For FRAs, this fixed rate is the forward rate that will be compared to the floating market rate in order to determine whether a net payment is due to the payer or receiver of the forward rate.

202. For IRS with negotiated rates, the dealer's spread is an amount by which the fixed rate is raised above, or lowered below, its actuarially fair (or "true") level. This spread generates additional revenue for the dealer. The buy-side investor incurs this spread on every subsequent payment date throughout the tenor of the swap, paying additional interest if paying the fixed rate, by an amount equal to the spread applied to the notional amount, or receiving less interest, similarly computed, if receiving the fixed rate.

203. As an example, consider a traditional fixed-floating IRS referencing the USD LIBOR rate, in which the fixed rate is to be paid semi-annually for five years. If the actuarially fair fixed rate of interest for this swap is 1.850% per annum on a certain date, and the dealer charged a rate of 1.851% to an investor seeking to pay fixed, this investor would pay an extra 0.001% of the notional amount each year as a spread to the dealer in order to secure the transaction. Given that payments are semi-annual, the investor would pay half this annual rate, or 0.0005%, on the notional amount at each of the ten payment dates over the five-year life of the swap. These ten future spread payments are fully identifiable from the dealer spread and swap's notional amount. On a five-year swap, this present value could be close to five times the annual spread, indeed a bit less due to the time value of money.[215]

204. This arithmetic of spreads also governs how buy-side investors are damaged if the dealer is able to charge an "excess" spread. In the world of dealer spreads, the negotiated rate, and hence the dealer spread within it, is a "zero-sum game": benefits to the dealer from an excess markup of the spread are losses extracted from the buy-side counterparty. In the example above, if the dealer is able to charge a spread of 0.002% rather than just 0.001%, the *additional* or *excess* spread of 0.001% captured by the dealer is also incurred by the buy-side investor as an annual *excess* cost, paid on the notional amount of the swap, for the lifetime of the swap. The damages incurred by the buy-side investor is the present value of the *excess* cost paid each year over the life of the swap.

205. The formulas for computing this present value, and therefore damages, are straightforward and widely accepted. If the excess spread charged by the dealer in the fixed rate is established (*e.g.*, an excess rate of 0.001%), the excess spread-cost incurred by the buy-side investor is a known and constant amount each year during the swap's lifetime, equal to the excess spread times the notional amount. In other words, the excess spread-cost is an annuity (*i.e.*, a constant dollar stream of payments) over the swap's tenor. Standard annuity formulas provide the present value of this stream of excess spread-costs, typically expressed as a multiple of the annual cost. Analogous to the present value of the dealer spread in the five-year swap example above,

[215] The spread-related cost applies similarly, although in reverse, for investors opting to receive fixed. If the spread in the annual fixed rate is 0.001%, then each year the investor receives interest payments that are ($0.001% × Notional Amount) less than the payments it would have received under an actuarially fair fixed rate. This foregone interest is the cost imposed by the dealer's spread and would likewise, in present value terms, be close to five times the annual cost for a five-year swap.

the present value of the excess spread, which represents damages, would be a little less than five times the annual excess spread.

206. More generally, the damages from the excess spread can be expressed, on an annual basis, and appropriately adjusted for shorter periods, with the formula are: Damage equal Present Value Factor × (Excess Spread × Notional Amount). The "Present Value Factor," also known as "DV01", is a multiple determined by the swap's tenor, the periodicity of fixed payments within each year, and an appropriate discount rate. Continuing with the example, if the excess costs are incurred semi-annually for five years, and the discount rate is 1.852%, the DV01 is approximately 4.75. This means that the annual spread-cost has a present value that is approximately 4.75 times the annual cost.[216]

207. MAC swaps differ from other IRS in that the fixed rate to be paid under this fixed-for-floating swap, rather than being negotiated at the time of the transactions, is already specified, on a relatively stale basis, as one of the swap's contractual features. Moreover, the start (or "effective") date for a given class of MAC swaps is the same from one transaction day to the next. While this feature produces identical future cash flows for yesterday's and today's contract--super standardizing them-- a stale fixed rate cannot ensure that the exchange of fixed for floating payment is fair as time evolves and interest rates change. To account for this feature, the MAC swap have to transact at an upfront price, paid by the payer of fixed to the receiver if the stipulated fixed rate is below its actuarially fair level on the transaction date and by the receiver to the payer if the reverse is true.

208. Bid-ask spreads for MAC IRS are embedded in this upfront price, raising the price if it is being paid by the buy-side investor to the dealer and lowering the price if it is being paid by the dealer to the buy-side investor. If the dealer charges an "excess spread" from the buy-side investor, the damages suffered by the investor can be measured as the excess spread times the notional amount in the swap. Since the upfront price already reflects the present value of payments

[216] DV01 represents the multiple that determines the present value of the stream of dollar spreads effectively incurred by the buyside investor at each payment period as part of the overall fixed payment made to or received from the dealer by the investor. The DV01 for any transaction is determined by two factors: (1) the annual interest rate at which the stream of spreads incurred at each payment period is to be discounted to determine their present value, and (2) the number of future fixed payments required under the swap. For example, if the swap has a five-year tenor and semi-annual fixed payments, half of the annual spread is incurred at each semi-annual payment for ten such payments. This stream is discounted to the present using the semi-annual equivalent of the annual interest rate.

over the entire life of the swap, no further adjustment (*i.e.*, DV01) is necessary to compute damages once the excess spread embedded in the up-front price is known.

209. In summary, for all in-scope IRS transactions by class members, I measure the difference between actual spreads incurred during the class period and those that would have prevailed in the "but for" world. I use the term "spread compression" to denote the extent to which class period bid-ask spreads would have shrunk were there no excessive bid-ask spreads, as is the case in the but for world. Class members suffered damages by having been denied this "spread compression" from the beginning of the class period on.

210. The next subsections address the two steps required to measure damages: (1) measuring the actual spreads paid during the class period and (2) determining the spread compression that would have occurred in the but for world. The inputs required for this analysis include the specific products affected, their tenors, the transaction date, discount rates at the transaction date, and the extent of spread compression for that product class in the but for world. The particular details of how these elements are computed, *i.e.*, what information is used, can be easily adjusted if the fact-finder or the Court deems it appropriate.

C. Actual World Spreads

211. From an economic perspective, the spread paid by a buy-side investor on an IRS transaction can be characterized as an amount added to (or subtracted from) the "true value" of the relevant negotiated term on the swap (a fixed rate for non-MAC IRS and an upfront price for MAC swaps). In settings where a dealer's bid or ask quotes are not firm and are subject to further negotiation, the spread actually paid by the investor—called the "effective spread"—may differ from the dealer's "quoted spread" for the transaction, measured as the difference between the bid or ask quote and the "true value."[217] For example, if the transaction executes at a rate inside the quoted spread, the effective spread is smaller than the quoted spread.

[217] The quoted spread for a particular transaction is also sometimes referred to as the quoted half-spread to distinguish it from the overall bid-ask spread, which can be seen as the total spread charged by a dealer to both sides of a market. Thus, if an investor were to execute a payer transaction in a traditional fixed-floating IRS at the (higher) ask rate quoted by the dealer, and immediately reverse it by executing a receiver transaction for the same notional amount on the same IRS, the investor will still incur a net annual cost (per dollar of notional) equal to the ask rate minus the bid rate, *i.e.*, the bid-ask spread. Thus, the bid-ask spread can be seen as the cost of two offsetting (or "round-trip") transactions on opposite sides of the same market. Where useful for clarity, the spread embedded in just the ask or the bid quote is therefore referred to as a quoted half-spread.

212. Although effective spreads may differ from quoted spreads, data on dealers' quotes play an important role in measuring the effective spreads paid by investors. The reason is that the "true value" of the negotiated term is not directly observable at the time of the transaction. However, since dealers set their bid and ask quotes on either side of this "true value," we can infer that at any point in time, the "true value" lies in between the bid and ask values quoted at that point in time.[218] Typically, the "true value" is taken to be the mid-point between the bid and ask quotes (or the "mid-quote"). Therefore, when data on bid and ask quotes are available, the effective spread paid by an investor on an IRS transaction can be measured as the difference between the negotiated fixed rate or upfront price and the prevailing mid-quote for this variable. For this measure to be reliable, it is essential that we have accurate time-stamps for both transactions and dealer quotes, since quotes are updated continually during a trading session. Matching a transaction at one time to a mid-quote prevailing at another could cause errors in measuring effective spreads, particularly when the time difference is non-negligible.

213. When reliable quote data are not available, researchers attempt to infer bid-ask spreads by observing just the negotiated terms (fixed rates or prices) of nearby transactions in the same instrument. The intuition behind these measures is that if transactions occur frequently, the amount by which the price moves between closely proximate buy and sell transactions likely reflects only the total effective spreads paid by investors on the two sides of the market, so that the spread paid on a given transaction can be taken to be half of this observed spread.[219] However, if transactions in the instrument do not occur in high frequency, such price-based measures of the spread face two challenges: first, the few transactions occurring in close proximity to the subject transaction may be predominantly on one side of the market, making it difficult to reliably observe a spread, and second, the underlying "true value" of the instrument may have moved in the time that separates these transactions, so that differences in these prices and that of the subject transaction may reflect only changes in fundamental valuation rather than the bid-ask spread.

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[218] *See, e.g.*, Henrik Bessembinder and Kumar Venkataraman, "Bid-Ask Spreads: Measuring Trade Execution Costs in Financial Markets," *Encyclopedia of Quantitative Finance*, (Rama Cont ed., 2010) (survey of research on bid-ask spreads).

[219] To simplify the exposition, I have assumed the negotiated term is a price, as in stock transactions. *See, e.g.*, Roll, Richard, "A Simple Implicit Measure of the Effective Bid-Ask Spread in an Efficient Market," *The Journal of Finance*, Vol. 39, No. 4. (September 1984), pp. 1127-1139; Thompson, Sarahelen R. and Waller, Mark L., "Determinants of Liquidity Costs in Commodity Futures Markets," *The Review of Futures Markets,* Vol. 7, No. 1, 1988, pp. 110-126.

214. As discussed below, I use both quote-based and price-based measures of the spread as appropriate.

1. Transaction and Quote Data

215. Bloomberg and Tradeweb Markets LLC ("Tradeweb"), which operate the two major dealer-to-client SEFs, have provided detailed, time-stamped data for all IRS transactions executed on their SEFs from October 2013 until December 2017. The data identifies [redacted] also provided such data for certain [redacted]

216. For all other transactions executed outside a SEF, the information available to me came from datasets produced by Defendants and the Part 43 data discussed previously.[220] However, in the limited time since these sets were made available to me, it has not been possible to verify, de-duplicate, and fully integrate data across these sources and from the SEFs for reasons described more fully in Appendix 3. Such integration is needed to reliably identify time-stamped off-SEF IRS transactions that can be confirmed as dealer-to-buy-side with the requisite time stamps and trade details necessary to measure effective spreads. Among other issues, certain dealer datasets lacked time stamps and others contained extensive redactions of counterparty information that made it impossible to identify dealer-buy-side transactions. My analysis and incorporation of these datasets continues. Again, my model is readily able to incorporate additional datasets if and when they become available.

217. Defendants have stated that [redacted]

[220] Bloomberg and DTCC, as swap data repositories, also report transactions data on IRS publicly under their Part 43 reporting obligation, and this data includes execution time-stamp, fixed rate (or upfront price), notional and key contractual details of the IRS transacted. However, this data does not identify the counterparties to each trade. As a result, I am unable to tell which transactions involved dealer-to-buy-side trades and which ones interdealer trades. I discuss this data in Appendix 3.

[redacted]Therefore, analyses requiring such quotes employ publicly available data on IRS quotes where available. In its capacity as a commercial data-provider, [redacted][221] [redacted]

218. [redacted][222] For these IRS, I perform a direct statistical analysis of effective spreads by comparing time-stamped transactions records with contemporaneous bid and ask quotes from [redacted]

2. Statistical Analysis of Effective Spreads

219. Transactions in IRS during the class period took one of two forms: (a) "outright" transactions, in which the IRS was entered into as a distinct transaction by the buy-side investor, and (b) "package" transactions, in which the IRS was entered into simultaneously with one or more

[221] *See* "[redacted]," available on [redacted]

[222] In order to find a Bloomberg quote series applicable to a certain IRS, the features of this IRS have to be compared to those of each available Bloomberg quote series on the dimensions provided by Bloomberg to establish whether the quote series is applicable to the security. This process of matching can be time-consuming and therefore affects the number of IRS for which it is practical to identify quote data in the time available for this report. I describe the methodology I implement to match CMPN quote data to the Bloomberg and Tradeweb SEF platform data at Appendix 4.

other fixed-floating IRS to create a portfolio with investment attributes distinct from outright IRS. The data provided by Bloomberg and Tradeweb indicate [redacted][223] In Parts B to E of this section, I focus on bid-ask spreads and associated damages for outright IRS transactions during the class period. In Part F, I extend my methodology to package trades.

220. In order to illustrate my approach to measuring the effective spreads paid during the class period, I initially analyze the effective spreads charged by dealers for an IRS contract that was actively traded during the class period: the 5-year traditional fixed-floating IRS on the 3-month USD LIBOR ("5Y 3M USD LIBOR"). Fixed-rate payments on this instrument are made semi-annually on a "30/360" day-count convention while floating rate payments are made quarterly on an "actual/360" day-count convention. Data from the Bloomberg SEF and Tradeweb show that [redacted]

221. My analysis covers the years 2013 to 2017. While Tradeweb has provided data on transactions from the beginning of 2013, Bloomberg's data begins only in October 2013, when it began operating its SEF. Between Bloomberg and Tradeweb, nearly [redacted] outright transactions were executed for this swap from 2013 to 2017, involving approximately [redacted] in notional volume.[224] Although the majority of transactions in this instrument were executed on-SEF during this period, the data also includes off-SEF transaction records provided by Tradeweb. These off-SEF transactions represented about [redacted]% of total transaction records available from Bloomberg and Tradeweb for this contract.

222. To compute effective spreads, each time-stamped transaction in the Bloomberg SEF and Tradeweb data was matched to the time-stamped Bloomberg composite best bid and ask quote closest in time prior to the transaction. For about [redacted]% of all transaction records, I was unable to find Bloomberg quotes updated within one minute before the trade; I drop these transactions from my analysis. For the [redacted] contract, [redacted] correspondingly, the Bloomberg quotes are also expressed as [redacted]

[223] I discuss package transactions more fully below. Since the spreads charged by dealers on a package could, in principle, be different from those charged on stand-alone or outright transactions, I first focus on the effective spreads of outright transactions.

[224] Based on transactions data provided by the Bloomberg SEF and Tradeweb.

[redacted]

223. The effective spread on an IRS transaction is defined as the difference between the negotiated fixed rate and the "true value" of this rate at the time of the transaction. As noted above, the "true rate" would typically be taken to be the mid-quote prevailing at the time of the trade. In my initial statistical analysis, described more fully in Appendix 5, I do not presume that this proposition is true since the Bloomberg bid and ask quotes are indicative. Instead, I allow the data to indicate the most reliable inference of the "true rate" to be drawn from the prevailing bid and ask quote. Specifically, the model specifies the "true rate" to be a weighted average of the bid and ask quote, with the weights placed on the bid and ask to be determined by the statistical model in such a way as to best explain the observed data. Effective spreads are, in turn, determined by the difference between the negotiated fixed rate in the transaction and this model-inferred measure of the swap's "true rate" at the time. The model allows effective spreads to vary each year in order to reflect trends in this spread over the class period.

224. The results from estimating the statistical model for the 5Y 3M USD LIBOR are reported in Appendix 5.[225] Although the statistical model allowed for the possibility that the "true rate" for the 5Y 3M USD LIBOR contract could lie closer to the indicative best bid than the [redacted] the estimation of the model reveals that the "true rate" can indeed be estimated as a simple average of the bid and ask quotes, or equivalently, the mid-quote. As shown in Appendix 5, the weight assigned by the model to the bid quote was approximately 43.69% and to the ask quote approximately 56.31%. These weights are not statistically different from 50-50 weights, *i.e.*, a simple average of bid and ask, or the midquote. Therefore, in subsequent analysis, the spread contained in a transacted rate is computed with reference to the midquote.

225. The model for the [redacted] was [redacted]

[redacted]

[225] Since the weights assigned to the bid and ask rate have to be constrained to add up to 100%, the model is estimated through a generalization of regression methods called a "generalized method of moments." When estimating effective spreads, it is necessary to account for the differences in negotiated swap rates observed during the class period between transactions cleared by LCH and those cleared by the CME, a difference labeled as the "CME-LCH basis." [redacted] This adjustment is discussed in Appendix 5.

[redacted] Table 3 below [redacted]

Table 3

[redacted]

226. In 2013, the first year of the class period, the average effective spread for a transaction in the [redacted] contract was [redacted] basis points, or [redacted]%. In other words, [redacted]

227. [redacted] In actuality, the effective spreads incurred on swap transactions likely varied according to the attributes of the transaction (*e.g.*, the notional amount traded), the manner in which the trade was executed (such as on or off a SEF) and cleared, and the attributes of the underlying contract itself (such as its tenor). In order to capture how actual effective spreads for IRS varied across these attributes during the class period, it is useful to examine data on a range of IRS transactions that represented various possible combinations of these attributes and analyze their effective spreads.

228. In order to measure the effective spreads associated with IRS transactions of various attributes, I analyzed transactions for 86 different IRS contracts over the class period for which I was able to identify [redacted]

[redacted][226]

Approximately [redacted] transactions were executed in these contracts between January 1, 2013 and December 31, 2017 in the data provided by Bloomberg SEF and Tradeweb SEF, accounting for about [redacted]% of the notional amount traded through these venues. [redacted]

229. The contracts included in my analysis represent a wide range of trading activity, notional value, and contractual specifications, thus making this data effective in establishing the factors affecting effective spreads paid in the actual world and thus measuring the effective spreads associated with particular transactions reliably.

230. Table 4 presents the range of key contractual features observed in the 86 IRS contracts analyzed in my model.

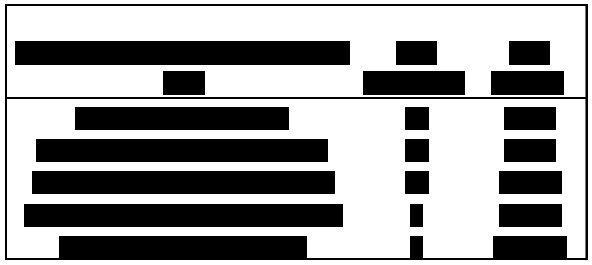
Table 4
Contractual Attributes of IRS Contracts in Statistical Analysis

231. [redacted]

[226] [redacted]

[redacted]

Table 5
Trading Frequency of IRS Contracts in Statistical Analysis



232. [redacted]

233. Using this sample of IRS contracts, I develop a statistical model to determine the effective spreads paid to transact IRS contracts with the different economic attributes observed during the class period. My analysis can address not only the spreads paid on the IRS contracts included within my sample but also on IRS that are outside my sample, because these IRS have certain economic characteristics in common with my sample IRS contracts whose effects on spreads can be established using a statistical analysis of the sample contracts.

234. [redacted] However, to the extent these instruments were traded in off-SEF transactions by

such investors, it is my opinion that my statistical model can reliably indicate the effective spreads paid on these contracts. As discussed in Section II, the economic attributes of FRAs are similar to those of other fixed-floating IRS, in that these contracts also involve counterparties negotiating a fixed rate to be exchanged with a floating rate in the future, the difference being primarily that the resulting payments are due at the beginning of the future payment period rather than at the end. My sample also does not include MAC IRS because these instruments are negotiated on a different economic variable (price) than other fixed-float IRS (fixed rates). However, a model for bid-ask spreads applicable to instruments transacted on a fixed rate can also indicate the spreads applicable to otherwise comparable MAC instruments trading on price because the price on a MAC contract is simply the expected net present value of the fixed rate stipulated in the contract. Therefore, the effective spread embedded in the price of a MAC contract is analogous to the present value of the effective spread applicable to the fixed rates of comparable traditional fixed-float IRS. Moreover, I intend to incorporate into my analysis any additional data that becomes available concerning such instruments.

235. The statistical model for effective spreads draws upon the findings reported for the 5Y 3M USD LIBOR contract. I [redacted] In order to identify the economic factors that affect the spreads paid on IRS transactions, I consider how spreads are related to the following attributes of the contract or the transaction:

- SEF-Trading: The instruments buy-side investors transact on a SEF are likely to have standardized contractual features that facilitate a meaningful RFQ process in which dealers can quote transaction terms without significant additional negotiation regarding unique contractual features. The RFQ process also elicits simultaneous quotes from a limited number of dealers, and thus might generate greater quote competition than negotiated off-SEF transactions. For these reasons, effective spreads on SEF-transactions are likely to be lower than spreads on other transactions, all else equal. I keep track of whether a transaction was on-SEF by using an indicator variable that takes a value of 1 if the transaction is SEF-traded and 0 otherwise.
- Clearing: IRS transactions that are cleared are likely to involve lower spreads than uncleared trades, other factors remaining the same, because clearing reduces the dealer's exposure to the credit risk of the buy-side investor. I use an indicator variable (taking a value of 1 when the transaction is cleared and zero otherwise) to keep track of whether a transaction was cleared.
- The Year of the Transaction: Having observed a decline in the spreads of the 5Y 3M

USD LIBOR, I use indicator variables for each year to track if spreads changed over time more broadly in the large sample of IRS contracts.

- Notional Amount: Since transactions involving larger notional amounts might entail greater risk for dealers, I examine if spreads are related to the notional amount in the transaction, expressed in billions of dollars.
- Tenor: For any given notional amount, a dealer might also face greater risk the longer the tenor of the contract, since fluctuations in interest rates have a proportionately greater impact on the net present value of long-dated swaps than short-dated swaps. Therefore, I include as an explanatory variable the tenor of the contract, measured in years.
- Trading Frequency: Since transacting an actively traded contract might entail less inventory risk for the dealer due to the prospect of entering offsetting transactions sooner, I examine whether spreads are negatively related to trading frequency. For each transaction in a certain contract, the trading frequency of the contract is measured by the number of trades executed in that contract in the month prior to when the transaction occurred.[227]

236. My statistical model allows the impact of SEF-trading and clearing on effective spreads to vary across the years 2013 to 2017 and to depend upon the particular combination of these attributes found in the transaction. In other words, the model allows effective spreads to vary according to whether a transaction was both on-SEF and cleared, on-SEF but uncleared, off-SEF but cleared, or off-SEF and uncleared. Moreover, the effective spreads associated with these attributes are allowed to further vary from one year to the next.

237. In addition to its SEF-trading and clearing status, the effective spread is also linked to the size of the trade as measured by the notional value transacted, the tenor of the underlying instrument and the trading frequency of the contract in the calendar month prior to the transaction.[228] The strength of these relationships are allowed to vary from one year to the next in the estimated model.

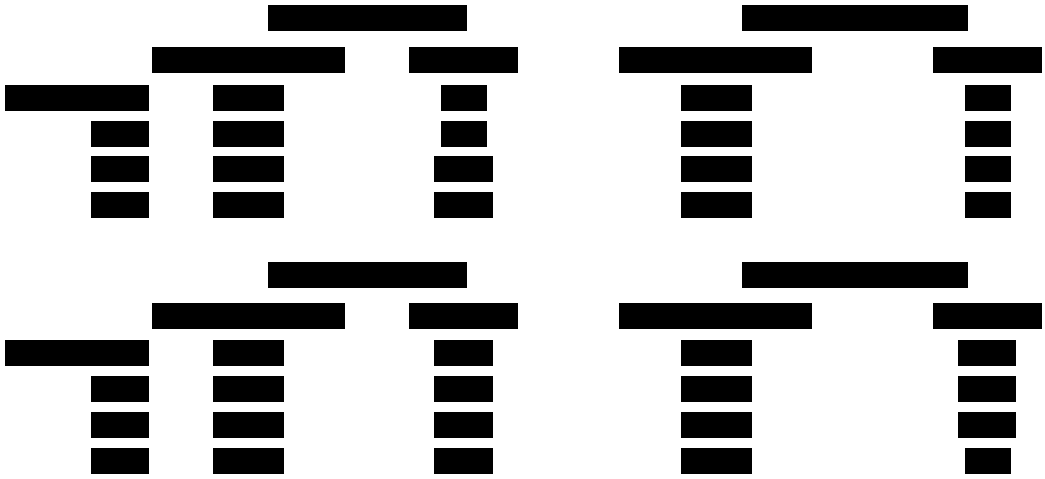
238. Table 6 presents the results from estimating this model of effective spreads on data for the sample of 86 IRS contracts described earlier.

[227] [redacted]

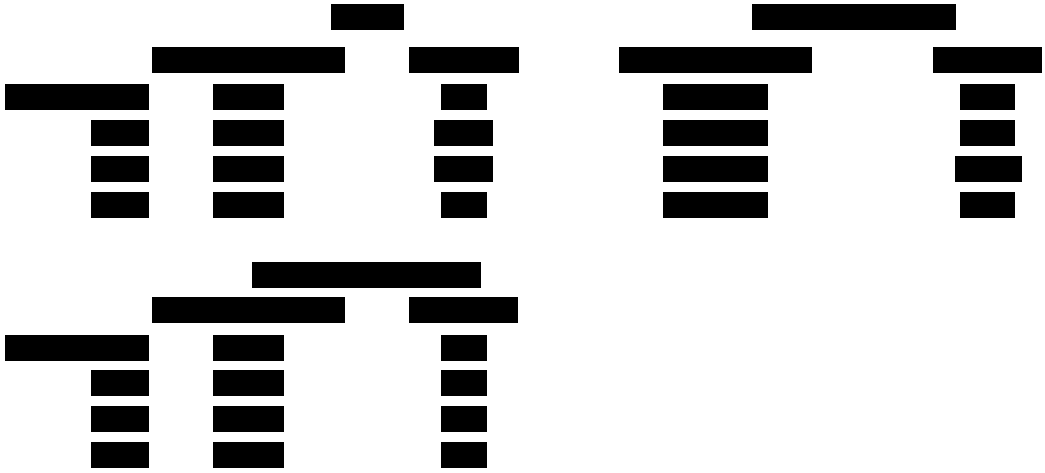
[228] [redacted]

Table 6
Estimated Coefficients for the Statistical Model of Effective Spreads[229]

A. Spread Coefficients by Year, SEF-Trading & Clearing



B. Additional Explanatory Variables



	Coefficient (bps)	t-statistic
Intercept:		
Mid-Coefficient		
Adjusted R-squared		
Number of Transactions		

239. [redacted] I have pooled the data for 2013 and 2014 and estimated my model under the premise that the coefficients of relationship in late 2013 was the same as in 2014.

240. The coefficients of the model laid out in Table 6 provide a method for estimating the actual effective spread associated with an IRS transaction executed during the class period, given its observable economic attributes and the manner in which it was executed. The coefficients in Part A of this table show the effective spreads each year for transactions with different combinations of SEF-trading and clearing, before taking into account the incremental spreads (positive or negative) associated with the contract's tenor and trading frequency and the notional amount in the transaction. [redacted]

241. Part B of Table 6 shows that in addition to the "baseline" spread associated with a transaction's trading venue (SEF, off-SEF) and clearing status, the overall spread contains an incremental component that increases with the size of the transaction and with the tenor of the contract, and decreases with the trading frequency of the contract. The coefficients that relate spreads to tenor, notional and trading frequency change from one year to the next.

242. In order to illustrate how the model in Table 6 can be applied to compute the effective spread paid on a transaction, I consider three hypothetical trades. Each trade is taken to have been executed on-SEF and cleared, but involving different economic attributes. Table 7 below shows the overall effective spreads associated with each transaction.

[229] [redacted]

Table 7

[redacted]

Trade Attributes	Trade 1	Trade 2	Trade 3
[redacted]	[redacted]	[redacted]	[redacted]
Year	On SEF, Cleared	On SEF, Cleared	On SEF, Cleared
Effective Spread in Actual World: [redacted]	0.1197	0.1095	0.0781
[redacted]	[redacted]	[redacted]	[redacted]
Change: [redacted] (bps)	[redacted]	[redacted]	[redacted]
Actual Decline in Spreads (%)	[redacted]	[redacted]	[redacted]

243. The first hypothetical trade ("Trade 1") is assumed to be at the "low end" of the range for each of the three attributes determining spreads (besides SEF trading and clearing), *i.e.*, notional value, tenor and trading frequency. Specifically, I have taken this trade to be at the 25th percentile of all trades in the sample with respect to each of these attributes. This trade involves a notional amount of just $10 million, on a swap with a 5-year tenor and a prior month's trading frequency of 76 trades.[230] The effective spreads for such a transaction that would have been charged in each year from 2013 to 2017 can be computed from the coefficients in Table 6 as follows (and shown in the first column in Table 7):

[redacted]

Year	Baseline	Notional	Tenor	Trading Freq.	Intercept	Spread
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[230] Specifically, if all transactions in the sample are arranged in ascending order of each of these three attributes, the values stated in this sentence corresponds to the transaction that lies at the 25th percentile of the total sample on each attribute.

244. The second and third illustrative trades are taken to be at the median level and the "upper level" (*i.e.*, 75th percentile) of each trade attribute (notional, tenor and trading frequency). Their spreads can be calculated exactly as above, using their respective notional values, tenor and trading frequency (*i.e.*, Trades per month). The effective spreads for trades with similar attributes in any other category of SEF trading or clearing can likewise be computed by simply replacing the "baseline" spread of the "SEF-Traded, Cleared" category with those of the relevant alternative category. Therefore, the statistical model of spreads provides a methodology to compute effective spreads for all IRS transactions.

D. Spreads in the But for World

245. Earlier, I opined that (i) absent the alleged conspiracy, buy-side investors would have been able to transact most IRS in market venues with anonymous all-to-all trading protocols such as CLOBs and all-to-all RFQs; (ii) in all-to-all structures, the half-spreads incurred by class members would have been significantly lower than the spreads class members paid to dealers at any point during the class period; (iii) the lower spreads of anonymous all-to-all platforms would have had a spillover effect on OTC transactions in the but for world—generating lower spreads for transactions that remain OTC in the but for world, and causing most class transactions to migrate to all-to-all platform instruments even when actual world transactions occurred in an IRS instrument that remained OTC in the but for world. The purpose of this subsection is to quantify the degree of spread compression for all class transactions, including those that do not migrate to all-to-all platforms.

1. The Effect of Dodd-Frank on Spread Compression

246. The evolution of IRS spreads in the class period of the actual world provides significant statistical evidence of spread compression under anonymous all-to-all trading markets. It also provides level of compression that is below the floor of spread compression we might expect to see in the but for world. Under the partial improvements in transparency and liquidity brought about by Dodd Frank regulations, spreads have dramatically declined since 2013. As Section III noted, post-trade reporting, clearing, and electronic trading on SEFs have, to some degree, brought additional post-trade transparency, uncloaking the veil that was previously hiding the terms IRS counterparties recently agreed upon. Dodd-Frank also fostered additional competition by allowing buy-side investors to solicit quotes simultaneously from multiple dealers. Yet, the continued

imposition of name disclosure, boycotts of platforms that posed a threat to dealers' monopoly profits, and other allegedly collusive restrictions placed on buy-side trading have kept buy-side and interdealer markets effectively segregated, prevented the emergence of competitive CLOBs, and inhibited pre-trade transparency.

247. Notwithstanding these continued inhibitions on transparency and competition, the partial improvements mandated in the actual world by legislation and regulation have caused effective spreads for cleared, SEF-traded IRS to decline by about [redacted]% for a median trade (*i.e.*, a trade with median economic attributes) between 2013 and 2017, as Table 7 shows. That such limited improvements in competitiveness could drive down spreads by [redacted]% tells us, as a matter of economics, that spread compression would have been significantly greater on a fully anonymous all-to-all platform with no artificial limitations on buy-side trading activity.

2. Compression Evidence from the Structural Changes of Other Financial Markets

248. To evaluate the spread compression that would have been achieved in IRS if trading protocols for these instruments had transitioned fully to competitive, anonymous all-to-all markets, it is useful to begin by reviewing the range of spread compression that arose from the introduction of a few other competitive electronic platforms that should be familiar from my report. These include Treasury securities, WTI crude oil futures, and dividend swaps. Empirical evidence from these three markets indicate that the migration of standardized financial instruments to competitive, transparent, electronic trading platforms reduced their spreads by between 75% and 90% across these markets.

249. ***Treasury Securities:*** The interdealer market for Treasury securities, as introduced in Section IV, was predominantly a voice-brokered market until 1999, when Cantor Fitzgerald launched the first electronic trading platform for these securities and a consortium of dealers responded with a competing electronic platform called BrokerTec.[231] The subsequent competition and transparency brought about by these two platforms caused the spreads on Treasuries to compress by 75% to 82% by 2004.[232]

[231] The electronification of interdealer Treasury markets is documented by Mizrach. B. and Christopher J. Neely, "The Transition to Electronic Communications Networks in the Secondary Treasury Market, *Federal Reserve Bank of St. Louis Review*, November/December 2006, 88(6), pp. 527-41.

[232] *Id.* at p. 538.

250. The 75% to 82% compression in spreads, significant though it was, barely foreshadowed the full degree of competitive pressures that would emerge in electronic Treasury markets after 2004. These new competitive pressures were well-established by 2013, when the class period begins. It was only in 2004 that BrokerTec first opened its platform to a wider group of non-dealer liquidity providers, including PTFs and HFTs. As electronic trading technologies became increasingly sophisticated, these traders began competing with increasing effect in supplying liquidity through algorithmic trading strategies.

251. By October 2014, algorithmic traders, rather than dealers, were the dominant contributors of market volume and liquidity in certain Treasury instruments.[233] Economic science suggests this could only happen if the new contributors of volume and liquidity were producing tighter spreads. Moreover, it is my understanding that neither BrokerTec nor eSpeed is a fully all-to-all platform. Indeed, although the entrance of alternative market makers and transparent trading protocols have propelled spread compression, not all buy-side entities access these platforms.[234] As a result, the changes brought about by the introduction of electronic trading in Treasury securities provide, at most, a conservative "below floor" measure of the full degree of competition dealers would face in an anonymous all-to-all IRS market. The but for world of anonymous all-to-all platforms would have benefited from the additional competition in liquidity supply created not only by PTFs and HFTs but also from the participation of other buy-side entities as suppliers of liquidity.

252. ***WTI Crude:*** As Section IV noted, on September 5, 2006 the NYMEX first allowed WTI light sweet crude futures, the most widely traded energy contract on NYMEX, to be transacted electronically on the Globex platform alongside open outcry trading in the NYMEX's futures pits.[235] Using non-public transactions data provided by the CFTC, Raman, Robe and

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[233] Bech, M., Anamaria Iles, Ulf Lewrick and Andreas Schrimpf, "Hanging up the phone – electronic trading in fixed income markets and its implications," *Bank of International Settlements Quarterly Review* (March 2016), pp. 79-94; *see also* Joint Staff Report, The U.S. Treasury Market on October 15, 2014, U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, U.S. Commodity Futures Trading Commission, Table 3.3.

[234] *See* Dkt. No. 226 in Case No. 1:15-md-02673.

[235] Raman, Vikas, Michel A. Robe and Pradeep K. Yadav, "The Third Dimension of Financialization: Electronification, Intraday Institutional Trading, and Commodity Market Quality," November 2017, Research Paper, Office of the Chief Economist, U.S. Commodity Futures Trading Commission, accessed at https://www.cftc.gov/About/EconomicAnalysis/ResearchPapers/index.htm.

Yadav (2017) find that this "transformative easing of access from traders without access to the pits," which allowed these traders to compete effectively with "locals" in open outcry pits, reduced the estimated bid-ask spreads on WTI crude futures by more than 90% in a short window after the introduction of electronic trading.[236]

253. Like the experience with Treasury securities, the competitive dynamics triggered by the electronification of WTI crude trading are also informative about the market competition that would prevail in the IRS market's but for world. Raman, Robe and Yadav (2017) document that the introduction of electronic trading brought over 400 institutional traders into the WTI market over the next six months, including almost two dozen HFTs, who were new to NYMEX. Moreover, within a few months of electronification, the fraction of all Globex WTI futures trades with an institutional financial trader on either side grew to almost 60% of total volume.[237] Moreover, these institutional traders were focused on short-horizon strategies, like the "locals" who supply liquidity in open outcry pits, indicating that they are supplying liquidity to the market.[238] Analogously, the establishment of an open, transparent trading platform for IRS is likely to attract new institutional investors, including PTFs and HFTs, who have never participated in the market before and for whom an all-to-all electronic platform is likely to represent a new opportunity to make markets and compete in supplying liquidity. This infusion of new market-making capital is likely to drive down bid-ask spreads significantly, especially for standardized IRS, as happened with WTI crude futures.

254. ***Dividend Swaps:*** Recall the discussion from Section IV of dividend swaps, which allow purchasers of the swap to pay a fixed dividend amount at expiry in exchange for all actual qualifying dividends on the underlying stock or index during the life of the swap. First introduced in 1990, dividend swaps remained an OTC financial product until the Eurex listed a dividend futures contract referencing the EURO STOXX 50 Index. Following this exchange listing, bid-ask spreads on dividend swaps declined by 75% from 4 basis points to 1.[239]

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[236] *Id.* at Introduction, Section 4.1, Table 1 and Figure 1.

[237] *Id.* at Introduction, Section 4.2.1.

[238] *Id.* at Introduction, Section 4.2.2.

[239] Abouhossein, Kian; Ranjan, Amit; Kantarovich, Alex; Lee, Delphine; Klaczek, Josh; Francois, Nana; Bilandani, Naresh; Tsujino, Natsumu; Sinha, Raul; Martinez, Saul; Manning, Scott; Sen, Seshadri K.; Peterzens, Sofie; Gautam, Vivek; and Juneja, Vivek, "Can Universal Banking Model Survive the New Wave of Uncoordinated IB Regulations? OW Tier II IBs," JPMorgan, April 11, 2013, p. 73.

3. What Economic Theory and IRS Data Say About IRS Spread Compression

255. Turning to the attributes of IRS, it is my opinion that in a competitive market for liquidity provision, the bid-ask spreads on IRS, expressed as percentages of notional amounts, will be minimal, and indeed significantly lower than their current levels. First, IRS are transacted in very large notional amounts. Dealers can recover their fixed or infrastructural costs of market-making from what otherwise would be considered de minimis *percentage* spreads. Second, dealers have substantial opportunities to offset inventory imbalances in inter-dealer markets or hedge them in deeply liquid markets for government securities such as U.S. Treasury bonds. Third, the risk a dealer faces in trading with a buy-side entity with superior information and entering into a losing trade as a result (also known as the "adverse selection" risk of dealership) are low with IRS. This is because, as discussed earlier, interest rates are shaped primarily by macroeconomic forces that are the subject of significant public research and because dealers are likely to be well-informed about interest rates due to their participation in Treasury markets and auctions, as well as the credit markets. Therefore, in a competitive market, dealers will be unable to charge more than a minimal spread without provoking competition and the loss of trading volume.

256. As noted above (Table 7), the effective spreads on SEF-traded and cleared IRS trades have declined by [redacted]% for a median trade (*i.e.*, a trade with median notional amount, tenor, and trading frequency in the prior month) between 2013 and 2017. That even very limited improvements in competitiveness could drive down spreads by [redacted]% confirms my opinion that, as a matter of economics, spread compression would have been significantly greater on a fully anonymous all-to-all platform with no artificial limitations on buy-side trading activity.

257. IRS transactions that were executed on-SEF and cleared in the actual world are, in my opinion, eminently well-suited to receive the full benefits of spread shrinkage that would be brought out by anonymous all-to-all trading. The fact that a buy-side investor was willing and able to execute this transaction in the actual world through a name-disclosed RFQ and then have the transaction cleared indicates that this transaction was sufficiently standard in its economic terms to have been traded either on a central limit order book or an anonymous all-to-all RFQ with post-trade clearing. In the rare instance where such a trade would be executed through some market structure other than an all-to-all platform, the standardization associated with these types of IRS, which begets competition among potential liquidity suppliers, dictates that the trade would

receive the competitive spreads at which trades are executed on the all-to-all platform.

258. Since these transactions would have captured the full spread shrinkage created by all-to-all platforms, and since the competitive spreads dealers can charge for standardized products on an all-to-all platform will be minimal, it is my opinion that transactions conducted on-SEF and cleared in the actual world would, in principle, transact at an *additional* spread compression of close to 100% from their 2017 levels in the actual world. In light of this conclusion, which stems from the economic attributes of IRS, I conservatively allow an *additional* spread compression from 2017 levels of only 50% when computing the spreads that would be observed in the but for world for on-SEF, cleared transactions.

259. The damages indicated by this direct perspective are informed by and consistent with the empirical evidence, regarding the spread compression observed in other instances where instruments migrated to more transparent, competitive trading platforms. Table 8 below illustrates this consistency.

Table 8

[redacted]

Trade Attributes	**Trade 1**	**Trade 2**	**Trade 3**
Notional (billions)	[redacted]	[redacted]	[redacted]
Tenor	[redacted]	[redacted]	[redacted]
Trades in Prior Month	[redacted]	[redacted]	[redacted]
Year	**On SEF, Cleared**	**On SEF, Cleared**	**On SEF, Cleared**
Effective Spread in Actual World: [redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
Change: [redacted] (bps)	[redacted]	[redacted]	[redacted]
Actual Decline in Spreads (%)	[redacted]	[redacted]	[redacted]
Additional % Decline ([redacted])	[redacted]%	[redacted]%	[redacted]%
Effective Spread in But-For World:	[redacted]	[redacted]	[redacted]
Overall Compression Rate Relative to 2013:	[redacted]%	[redacted]%	[redacted]%
Historical Evidence:	[redacted]% to [redacted]%		

260. The portion of this table that computes effective spreads in the actual world and the decline observed in the spreads of on-SEF, cleared transactions through 2017 is identical to Table 7. For the three hypothetical transactions that reflect a range of economic attributes relevant to the spread, the decline in spreads in the actual world ranged from 57.0% to 68.8%. Under the

conservative conclusion that on-SEF, cleared transactions would have transacted in the but for world at spreads that were compressed by approximately [redacted]% more relative to their 2017 levels, the but for spreads for these transactions would range from [redacted] bps (Trade 3) to [redacted] bps ([redacted] These spreads represent a compression of between [redacted] and [redacted]% relative to the spreads prevailing at the beginning of the class period.[240] Therefore, if the world of anonymous all-to-all trading had already taken effect at the beginning of the class period, this analysis would indicate that spreads in this but for world would be between [redacted]% and [redacted]% lower than the spreads in the actual world at the time (*i.e.*, spread compression of[redacted]% to [redacted]%). This is entirely consistent with the empirical evidence from other markets I discussed earlier that experienced significant structural reforms to transparency and competitiveness resulting in spread compressions ranging from [redacted]% to [redacted]%.[241]

261. In light of this consistency between the alternative perspectives discussed above, I conclude that the spread compression that would have been realized in the but for world of all-to-all platform trading is no less than [redacted]%, relative the spreads paid for these transactions in the actual world in 2013. Therefore, I compute damages on an on-SEF, cleared transaction executed in the actual world as the effective spread paid on the transaction, given its economic attributes, minus a but for spread measured as [redacted]% of the effective spread for a transaction with matching economic attributes in 2013.

262. I believe my conclusion on spread compression, *i.e.*, [redacted]% relative to 2013 actual spreads is conservative for the reasons I have explained. However, to the extent that further fact developments or additional data available for this matter result in any incremental adjustments to

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[240] The three hypothetical transactions presented here represent a particular arrangement of trade attributes, with the first transaction being at the lower quartile of every attribute, the second at the median and the third at the upper quartile. Alternative profiles of attributes are certainly possible, such as a transaction that is at the highest quartile of notional and tenor but the lowest quartile of trading frequency or one with two attributes at the median and the third at the upper quartile. However, the percentage spread compression generated by these alternative profiles generally fall within the range shown in Table 8.

[241] I recognize that there are interest rate futures, transacted on futures exchanges, that can provide alternative mechanisms for hedging interest rate risk, as swaps do. These instruments are not, however, perfect substitutes for the swap market for various reasons, as evidenced by the volume of trading on swaps and several distinctions in their features. For example, Eurodollar futures have IMM start dates just like MAC swaps. However, futures pay interest in advance like FRAs whereas MAC swaps pay interest after the accrual period. Moreover, even if we compare FRAs with futures, there are differences in the way FRAs and futures are marked to market. I have written about how forward rate agreements and futures differ in their attributes and pricing in an article in the Journal of Finance. Grinblatt, Mark, and Narasimhan Jegadeesh, "Relative pricing of Eurodollar futures and forward contracts," The Journal of Finance, 51, no. 4 (1996): 1499-1522.

my estimated spread compression percentage, my model is fully capable of accommodating these alternative compression rates and producing an associated damages calculation.

263. For illustrative purposes, I assume that class members would have experienced the full benefits of spread compression starting at the beginning of the class period, though my methodology can easily be adjusted to calculate damages if a later "start" period if chosen. I believe my assumption that class members would have benefited from spread compression beginning no later than in January 2013. The same methodology could be used to calculate damages earlier than 2013 if it was found that the but for world could have commenced, as I suspect, prior to 2013.

E. Determining Damages

264. As I explain above, for IRS transactions that were executed on SEFs and cleared in the actual world, I compute the buy-side investor's damages as the difference between the actual effective spread paid in the transaction, given its attributes, and the but for spread, measured as [redacted]% of the effective spread of a transaction with matching economic attributes in 2013. The investor's total damage from this transaction is the present value of the periodic stream of excess spread payments incurred on the actual transaction, computed as the excess spread (in percentage terms) applied to the total notional value of the trade. Formally, the total damage is the DV01 of the excess spread payments in dollar terms, taking into account the periodicity of the payments.

Table 9

[redacted]

Trade Attributes				
Notional (billions)	$[redacted]			
Tenor	[redacted]			
Trades in Prior Month	[redacted]			
Year	**Actual Spread**	**But-For Spread**	**Excess Spread**	**Damages**
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
"But-For" Spread:	[redacted]			
Overall Compression Rate	[redacted]%			
Relative to [redacted] Actual Spread				

265. Consider a transaction with a particular set of economic attributes, *i.e.*, the notional value in the trade, and the tenor and trading frequency associated with the underlying swap. In the but for world, the spread on this transaction would have been only [redacted]% of the spread associated with an identical transaction in the actual world in 2013. If a transaction of these particular attributes had been executed in the actual world in 2013, the effective spread paid on this transaction would be [redacted] In this illustration, this but for spread is [redacted]bps. Given that the but for spread would have been no more than [redacted]basis points, the present value of total dollar damages can be computed as annual damages (the excess spread of [redacted]basis points times the notional amount) times the present value factor "DV01", which captures the value of incurring this excess spread each year during the life of the contract. As the effective spread declines in the actual world, transactions initiated in subsequent years with the same economic attributes will incur progressively less damages. However, damages are always positive.

266. Next, I turn to transactions that, in the actual world, occurred off-SEF, or were uncleared, or both. These transactions also suffered damages, for reasons I discussed in Section IV. *First,* for an on-SEF uncleared transaction that, in the actual world, involved an IRS that was standardized and actively traded, investors in the but for world would be incentivized to execute these as cleared transactions on an all-to-all platform because of the low bid-ask spreads charged

on such platform trades.[242] *Second*, for on-SEF and uncleared transactions or off-SEF transactions in less actively traded IRS, Section IV points out that that these instruments are likely to experience dramatic increases in trading volume. These volume increases in the but for world would sustain platform trading as evidenced by the prior experience of equity options and other instruments migrating from OTC trading to exchanges. Moreover, platform trading can sustain even thinly traded variants of actively traded IRS, as evidenced by the presence of deep in- or out-of-the-money options on equity exchanges. *Third*, many investors who traded less active IRS off-SEF in the actual world would have an economic incentive to substitute into similar standardized IRS actively traded on platforms in order to benefit from the low bid-ask spreads associated with these swaps in the but for world. *Fourth,* even with respect to transactions that would have been conducted outside a platform in the but for world, spreads on these transactions would have been lower in the but for world because of the greater price transparency and market-making competition created by platform trading for off-platform transactions.

267. Although many transactions that were not cleared and SEF-traded during the class period would have, consistent with the attributes I identified in Section II, been suitable for anonymous all-to-all trading, I compute damages for these transactions under a deliberately conservative methodology that is analogous to the methodology I use to compute damages for cleared, SEF-traded products.

268. Regardless of whether these transactions occur on an anonymous all-to-all platform or off-platform in the but for world—which warrant application of an approximately [redacted]% compression rate versus 2013 spreads—I conclude that the *magnitude* of the spread compression experienced by these transactions in basis points will be no less than the *magnitude* of basis point spread compression applicable to an on-SEF, cleared transaction with the same economic attributes. As the magnitude of basis point compression of analogous transactions is, as I demonstrate below, significantly less than the compression applied to the SEF traded and cleared

[242] By clearing this transaction, the buy-side investor will incur clearing costs it would have incurred on the uncleared trade in the actual world. However, in exchange, the investor also receives a commensurate economic benefit it did not get in the actual world, *i.e.*, protection from the default risk posed by the counterparty. If the clearing costs and margin payments are fairly priced, the clearing payments made to avert counterparty default risk will be no greater, in present value terms, than the anticipated costs arising from counterparty default. Therefore, the additional clearing costs incurred by the investor are offset by the additional value of the credit protection it receives. Therefore, no additional adjustment is necessary for these clearing costs when computing damages.

transactions, this is an extremely conservative assumption.[243]

269. As an example, consider an actual world in which the effective spreads for a non-cleared or off-SEF trade, given its economic attributes, was [redacted] basis points and that of a cleared, SEF-executed trade was [redacted] basis points respectively. If the effective spread for an on-SEF, cleared transaction with the same economic attributes decreases by [redacted]% or [redacted] bps, my damages methodology assumes that the non-cleared or off-SEF transaction would also have experienced the same *magnitude* of spread compression, *i.e.*, a reduction of [redacted] bps, in the but for world (for example, a decrease in its spread from [redacted] bps to [redacted] bps). I refer to this common *magnitude* of compression as "arithmetic compression."

270. My assumption of identical arithmetic compression is conservative. As shown in the statistical analysis above, transactions executed off-SEF, or uncleared, or both, generally occur at higher effective spreads than on-SEF, cleared transactions with the same notional, tenor and trading frequency of the underlying contract. Therefore, a given spread-reduction in basis points represents a smaller *percentage* compression rate than it does for the matching on-SEF, cleared transaction with the same economic attributes.

[243] This methodology is also supported by the fact that there was a similar relationship between spread compression in the actual world for the those products that both traded on-SEF and were cleared, and those that were not. *See supra,* Table 4.

Table 10

[redacted]

Trade Attributes				
Notional (billions)	[redacted]	[redacted]	[redacted]	[redacted]
Tenor	[redacted]	[redacted]	[redacted]	[redacted]
Trades in Prior Month	[redacted]	[redacted]	[redacted]	[redacted]
Year	**On SEF, Cleared**	**On SEF, Uncleared**	**Off-SEF, Cleared**	**Off-SEF, Uncleared**
Effective Spread in Actual World: [redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Overall Compression Rate Relative to 2013:	[redacted]	[redacted]	[redacted]	[redacted]
But-For Effective Spread	[redacted]	[redacted]	[redacted]	[redacted]
Arithmetic Compression (Bps)	[redacted]	[redacted]	[redacted]	[redacted]

271. Table 10 illustrates this point, using the determinants of effective spreads for off-SEF transactions. For example, consider a transaction occurring in any of the three categories of On-SEF and Uncleared, Off-SEF and Cleared or Off-SEF and Uncleared. For illustration, take this transaction to have first quartile values for the relevant economic attributes of notional, tenor and the frequency of the contract's trading in the prior month. A matching transaction conducted on-SEF and cleared would have realized a spread compression of [redacted]%, which would have translated to a *magnitude* of [redacted] basis points in spread compression. By assigning this same *magnitude* of spread compression to transactions in the other three categories, the model assigns these transactions a smaller *percentage* compression rate. This is because the initial level of spreads for a matching transaction in these categories is higher.

272. By applying a common "arithmetic compression" to transactions that occurred off-SEF or were uncleared, I base my damages calculation on the readily observable empirical details of how the transaction occurred in the actual world, rather than on a further consideration of how it would have occurred in the but for world (*i.e.*, whether it would have migrated to platform trading or not in this alternative world). In doing so, I have understated the damages associated with these transactions for a number of reasons.

273. *First*, as I have stated, there would be product conversion. Some less liquid IRS contracts will trade on all-to-all platforms in their current form; others may require minor

modifications to be more standardized and trade on an all-to-all exchange platforms. Exchange-traded IRS, for reasons outlined throughout my report, tend to have lower bid-ask spreads than those trading in an OTC or limited RFQ market. In addition, as noted in Professor Duffie's report, even previously thinly traded contracts could migrate to anonymous all-to-all trading with little to no change to their economic terms. Even the less-standardized and liquid contracts within the class definition could have traded on anonymous all-to-all platforms in the but for world.

274. *Second*, the but for world would trigger customer migration across product lines. Class members transacting in those less liquid swaps that are unlikely to convert to an exchange platform may migrate their IRS trades to cheaper, more transparent, and fairly standardized exchange-traded swaps. These swaps would differ from the actual-world swap these class members actually transacted in. However, when comparing the cost and benefit of migration, these class members may find that the lower cost of exchange-traded swaps outweighs the relatively greater non-pecuniary benefits of the actual-world swap.

275. *Third*, the transparency of fair pricing has market-wide effects that directly impact off-platform products, as my prior discussion of the academic literature in Section IV indicated. Thus, class members in the but for world trading less liquid IRS would be better-informed and savvy in their interactions with dealers, lowering the half spreads they pay.

276. Dealer economics and how dealers allocate resources and compete across lines of business also explain why arithmetic compression in half-spreads is appropriate and conservative. Recall (from Section II) that the dealer's actual spread for a swap is the sum of the competitive or but for spread, plus an amount attributable to monopoly rents. A firm that wants to maximize its profits can only do so by maximizing its monopoly rent. As a basic principle of economics, the allocation of the dealer's resources to different types of IRS has to make the monopoly rent elasticities the same across different IRS products. If type A IRS had higher monopoly rent elasticity than type B, it would be more lucrative to shift resources to type A IRS and out of type B IRS.

277. To illustrate my point here, recall from my example above, I assumed that an off-SEF and/or uncleared transaction and an alternative matched on-SEF, cleared transaction had year 2016 half spreads of 0.4 bps and 0.2 bps, respectively. The 0.4 bps swap has a higher spread only because it is more costly for the dealer to transact. The spread on the on-SEF, cleared transaction has a monopoly rent of 0.16 bps because that is the arithmetic spread compression in the but for

world. If the off-SEF or uncleared transaction has a smaller monopoly rent within its half-spread of 0.4 bps, dealers in the actual world would shift resources and/or alter pricing to increase the notional of the matched IRS at the expense of less notional in off-SEF or uncleared transactions. This is because a $1 shift in the notional from off-SEF or uncleared to on-SEF, cleared transactions increases monopoly rents.

278. For example, raising the half-spread on the off-SEF or uncleared transaction to above 0.4 would increase its monopoly rent. If the counterparty in this transaction does not migrate to the swaps in the on-SEF, cleared transaction, more profits are earned. This process continues until the dealer incentivizes the dollar of notional to migrate to the matched liquid swap. Hence, if we observe the buy-side counterparty in the off-SEF or uncleared swap, it has to offer the same or higher monopoly rents to the dealer.

279. Alternatively, the dealer could reduce its costs of supplying the dealership services to the off-SEF or uncleared transaction and maintain the same price. The cost reduction, which may involve altering small features of the underlying instrument, or devoting less handholding to the client, make the swap cheaper to the dealer but less attractive to the client. Again, if the client does not migrate, the dealer is increasing monopoly rents. This process would also continue until the marginal monopoly rents on the off-SEF or uncleared transactions equal or exceed those of the on-SEF, cleared substitute provided that we observe the client in the customized swap.

280. If, in response to these changes, the client migrates notional to the instrument in the matched on-SEF, cleared transactions, the dealer also increases monopoly rents because of the hypothetical example's impossible assumption of larger monopoly rents for the matched liquid IRS. In sum, the monopoly rents built into the matched on-SEF, cleared transaction spreads cannot exceed the monopoly rents on the off-SEF or uncleared transaction. If they do, the dealer is not optimizing profits across its lines of business. Thus, when the but for world eliminates monopoly rents, it is eliminating a rent within the spread of the off-SEF or uncleared transaction that is at least as great as the monopoly rent built into the matched on-SEF, cleared IRS spreads.

281. Finally, in terms of damages on off-SEF or uncleared transactions by class members, whenever product substitution takes place in the but for world, it is because the class member found it more advantageous to substitute than to continue transacting in the off-SEF or uncleared swap. In this case, damages exceed that damage figured from spread compression in the off-SEF or uncleared transaction itself.

282. In sum, homogenous arithmetic spread compression offers a conservative way to estimate damages for class members engaging in off-SEF or uncleared transactions. I conclude that even IRS that would continue to transact via RFQ protocols or OTC in the "but for" world would experience compression in their effective spreads that is at least as large as the arithmetic spread compression observer for related on-SEF, cleared transactions in standardized swaps.

283. This methodology is the same for all class members and IRS trades, and can be used to calculate damages regardless of the type of product traded, the specific date it was traded, or the class member that traded it.

F. Analyzing Package Transactions

284. As Section V noted earlier, transactions in IRS that were executed as a combination of more than one individual IRS contract have been set aside for an analysis performed separately from outright transactions. These transactions, commonly referred to as *package transactions*, involve a trader taking offsetting positions in multiple contracts in the hope of realizing profits from the difference between fixed rates. As I discuss below, the two main types of package transactions, curves and butterflies, also need to be analyzed separately due to structural differences between these two types of contracts.

285. Data from Bloomberg and Tradeweb allows identification of trades executed as part of a package—the overwhelming majority being *curve* or *butterfly* trades. In a curve trade, two IRS of different tenors are traded simultaneously and in opposite directions, thus expressing a view on the difference between two different maturity points on the yield curve. For example, a curve trade could consist of a long position in a 2-year swap and a short position in a 10-year swap, reflecting the view that the difference between the 2-year and the 10-year yields will narrow—such trades are referred to as flatteners, while the inverse of this trade (that is, a short position in a 2-year swap and a long position in a 10-year swap) is referred to as a steepener. A curve transaction is settled in a single cash payment that represent the difference between the two fixed rates in the two legs *i.e.*, in the examples above, the investor would receive (in case of a flattener) or pay (in case of a steepener) the difference between the 2-year and the 10-year fixed rates.[244]

286. The other frequently used combination trade is called a *butterfly*. A butterfly trade is a way for a trader to express a view on the difference between slopes of the yield curve at

[244] *See* Corb, *Interest Rate Swaps and Other Derivatives*, pp. 361-362.

different points, that is, on the curvature of the yield curve. By way of an example, if an investor believes that the 2-year-to-5-year part of the yield curve is too flat relative to the 5-year-to-10-year part of the yield curve, the investor can buy a 2-5-10 butterfly by taking a payer position in the 2-year and 10-year IRS and taking a receiver position in the 5-year swap.[245]

287. If the investor executed all legs of a package trade as independent then even though these legs represent offsetting positions, the investor would have paid a spread for each leg of the transaction. In practice, dealers quote a composite rate for package transactions by quoting a net transaction rate that represents the difference between the receiver and payer interest rates in the package. For example, if a buy-side investor seeks to initiate a curve trade by receiving the 5-year fixed rate and paying the 2-year fixed rate associated with the 3-month USD LIBOR at a time when the former exceeds the latter, the dealer would quote a net transaction rate representing the difference between the 5-year and 2-year rates. In this example, the dealer would extract a spread by quoting a difference lower than the difference between the "true rates," so that the buy-side investor receives a smaller net rate than in a world without spreads.

288. Bloomberg provides data on these composite quotes for both curve and package transactions. Thus, for these transactions, the data is analogous with that used in the analysis of outright contracts in that one can observe a negotiated rate and a bid and ask quote, whose mid-point can be taken as an estimate of the 'true value' of this net transaction rate. These two items of data for each transaction makes it possible to analyze the package transactions using a methodology that is analogous to that used for the outright transactions, as discussed in Section V above.

289. The overwhelming majority of package transactions are executed on SEFs and are cleared: [redacted]% of curve trades and [redacted]% of butterfly trades used in the analysis are executed on the Bloomberg SEF or Tradeweb SEF and were cleared. Supporting this observation, ClarusFT also reported that virtually all package transactions are executed on SEFs and are cleared. Therefore, the data used in this analysis of curve and package transactions is likely to represent the majority of packages transactions during the class period.

290. The data on package transactions indicate the composite rate charged to the investors entering these transactions. Quotes obtained from Bloomberg show the composite best

[245] Sadr, Amir, *Interest Rate Swaps and their Derivatives: a Practitioner's Guide*, Vol. 510 (John Wiley & Sons, 2009), p. 15.

indicative bid and ask quotes for curve and butterfly packages, establishing the spreads paid in the actual world for package transaction. In the but-for world, the model developed above establishes the competitive spreads that would prevail for each leg of the package transaction. Under the conservative assumption that the composite spread for a package trade would be equal to the spreads associated with trading each leg of the swap independently in the but-for world, the spread associated with the package in the but-for world can be established from the model developed above. The damages associated with a package trade is measured as the difference between the actual composite spread incurred on the package and this conservatively measured spread in the but-for world, expressed in dollar terms and present valued.

G. Preliminary Calculations Show that Class Members Suffered Approximately $[redacted] from Excessive Spreads During the Class Period

291. If Defendants are found liable, class members overpaid on the negotiated items they transacted with Defendants. Data limitations and Court rulings necessitate the caveat that I may refine my estimate of damages in this matter should better data become available. However, at this moment, I am able to generate a rough calculation of damages. Below I describe the components of my calculation. The damage range of $[redacted] to $[redacted] currently represents my best estimate of damages in this matter.

292. My calculation begins with the total notional volumes reported in the Part 43 data for all four product categories for the period 2013 through 2017. I note this notional volume understates the true volume transacted by market participants because of the Part 43 limitations on the reporting of block transactions. This notional volume is approximately $[redacted]

293. Although Part 43 data reflects only new trades, I understand from information published by Clarus FT that a certain portion of the fixed-floating volume may reflect compression trades.[246] To be conservative, I exclude from the $[redacted] of Part 43 notional volume [redacted]% of this amount as a preliminary estimate for compression trades. With this adjustment, the notional amount is adjusted to approximately $[redacted]

294. My calculation also requires an estimate of the percentage of total volume that represents buy side transactions with Defendants. The Bank of International Settlements provides

[246] Clarus Financial Technology (FT), *Compression in Swaps*, https://www.clarusft.com/compression-in-swaps/. This adjustment is made only to the notional volume of fixed-floating IRS.

regular estimates of IRS trading (referred to as turnover) by three industry segments, Reporting Dealers, Other Financial Institutions and Non-Financial Customers. I reviewed two BIS reports relevant to the class period and observed that the percentage of turnover that pertained to Dealers was approximately [redacted]% in 2013 and [redacted]% in 2016, with the remaining [redacted]% and [redacted]% pertaining to Other Financial Institutions and Non-Financial Customers.[247] The BIS's statistics for Other Financial Institutions and Non-Financial Customers relate to global IRS markets and likely represents an upper bound for the share of the buy side in the relevant notional volume of IRS. To establish another end for a plausible range of the buy side's share of notional, I note that even if D2D trading is taken to represent approximately [redacted]% of total SEF trading—a reasonable upper bound in my opinion—and approximately [redacted]% of total off-SEF trading, the share of the buy side in total notional volume is no less than approximately [redacted]%. Therefore, I take the share of the buy side in total notional volume to lie between [redacted]% and [redacted]%. As my work continues, I expect to determine this buy side percentage from actual transactions data produced.

295. Certain transactions in fixed-float IRS involve package trades as discussed above. To identify such package volume, I first reviewed the Part 43 data to understand trading volumes on- and off-SEF. I also reviewed the data produced by Bloomberg and Tradeweb, which identified package trade volumes of approximately [redacted]% over the class period. With these inputs, I have estimated that [redacted]% of the buy-side notional volume in fixed-floating IRS pertains to package trades, and the remainder is attributed to outright transactions (both SEF and off-SEF). As my analysis continues, instead of using an estimate for package trades, it is my expectation that the percentage of notional volume associated with package trades will be determined from the attributes recorded for each transaction in trading records produced.

296. Based on the damages methodology described above, I determined damages as a percentage of notional volume for transactions within each category of IRS within the data set I have analyzed as described above (both SEF and off-SEF). For FRAs, as part of this preliminary estimate, I based my estimate of damages per dollar of notional with reference to damages observed for OIS, which are also short-term swaps. Applying these percentages of damages to the notional identified for each category I determined the aggregate damages on buy-side notional

[247] Bank for International Settlements, Triennial Central Bank Survey, OTC Interest Rate Derivatives Turnover in April 2013: Preliminary Global Results, September 2013; and Bank for International Settlements, Triennial Central Bank Survey, OTC Interest Rate Derivatives Turnover in April 2016, September 2016 (revised in December 2016)

volume were approximately $[redacted] to $[redacted]

297. I have been provided with information on certain transactions entered into by the lead Plaintiffs. Under the model I presented above, the effective spreads associated with these trades at the time they were executed, given their economic attribute and the manner in which they were executed, is [redacted] basis points, [redacted] basis points, and [redacted] basis points, respectively. Based on the same economic attributes, I also determined that the in the but-for world, the spreads paid on these trades would be [redacted] basis points, [redacted]basis points, and [redacted]basis points, respectively. Therefore, the spreads associated with these trades in the actual are higher than the spreads in the but-for world. The damages associated with these trades can be quantified as a product of the spread inflation, the notional of the trades, and the present value factor, or DV01 of the traded contracts. I quantify the inflation in the spreads of these trades by applying an [redacted]% decrease to the but-for spread trades of similar economic attributes and manner of execution are predicted to incur by my statistical model presented above. Performing the calculations shown below in Table 11, I find that the damages incurred by the class members on these three trades were $[redacted], $[redacted]and $[redacted]respectively.

Table 11

[redacted]

Bates Stamp: **Trade Date:** **Trade Time:**	[redacted]
Key Characteristics: Notional: Tenor: Trading Intensity (monthly): DV01:	
Effective Spread (bps) **But-For Spread (bps)** **Spread Inflation (bps)** **Damages**	

298. My research into the matters discussed in this report is ongoing, and I reserve the right to modify or supplement my opinions as additional information becomes available, including in response to the opinions of any experts retained by Defendants.

April 2, 2019

Professor Mark Grinblatt | Date

APPENDIX 1

CURRICULUM VITAE AND PREVIOUS FIVE YEARS OF TESTIMONY JANUARY 2019

BIOGRAPHICAL INFORMATION

CONTACT INFORMATION

Mark Grinblatt
UCLA Anderson School of Management

EMPLOYMENT HISTORY AND FACULTY APPOINTMENTS

2018-	UCLA, Distinguished Research Professor
2016-18	UCLA, Distinguished Professor
2011-18	UCLA, Japan Alumni Professor of International Finance
2008-13	UCLA, Senior Associate Dean and Director of the Ph.D. Program, Anderson School of Management
2005-11	UCLA, J. Clayburn LaForce Endowed Chair in Management
1996-2018	UCLA, Professor of Finance
1987-96	UCLA, Associate Professor of Finance (with tenure)
1989-90	Salomon Brothers, Inc., Vice President, Arbitrage Support
1987-89	The Wharton School, Visiting Associate Professor
1982-87	UCLA, Assistant Professor of Finance
1981-82	UCLA, Acting Assistant Professor of Finance
1979-80	Yale University, Teaching Assistant
1979	Economist, Board of Governors of the Federal Reserve, Washington, D.C.
1978	Economist, Glassman-Oliver Economic Consultants, Wash., D.C.
1977	Yale College, Math and Economics Tutor
1977	Amity Tutoring Institute, Math and Economics Tutor
1976	Actuary (summer intern), Equitable Life Assurance Society, N.Y.

EDUCATION AND DEGREES

Ph.D.	2011	Aalto University, Economics (honorary degree)
Ph.D.	1982	Yale University, Economics
M.Phil.	1979	Yale University, Economics
M.A.	1978	Yale University, Economics
A.B.	1977	University of Michigan, Ann Arbor, Economics and Mathematics Degree with High Distinction and High Honors in Economics, Regents - Alumni Scholar
	1976	Visiting Student, Amherst College

RESEARCH (*=1,000+ Google scholar citations, **500+ cites, *200+ cites, +100 cites)**

ARTICLES PUBLISHED OR FORTHCOMING

"State Pricing, Effectively Complete Markets, and Corporate Finance" (with K.M. Wang), January 2019, Journal of Corporate Finance, in progress, forthcoming.

"When Factors Don't Span their Basis Portfolios" (with K. Saxena), 2018, *Journal of Financial and Quantitative Analysis,* 53 (6), pp. 2335-2354, lead article.

"Improving Factor Models," (with K. Saxena), 2018 *Journal of Portfolio Managemen*t, 44(6), pp.74-88.

"Agnostic Fundamental Analysis Works," (with S. Bartram), April 2018, *Journal of Financial Economics*, 128, pp. 125-147.

"IQ and Mutual Fund Choice" (with S. Ikaheimo, M. Keloharju, S. Kupfer), 2016, *Management Science* 62 (6), pp. 924-944.

+"Neural and Behavioral Bases of Age Differences in Perceptions of Trust," (with E. Castle, N. Eisenberger, T. Seeman W. Moons, I. Boggero, and S. Taylor), 2012, *Proceedings of the National Academy of Sciences,* 109 (51), pp. 20848-20852.

*"IQ, Trading Behavior, and Performance," (with M. Keloharju and J. Linnainmaa), 2012, *Journal of Financial Economics*, 104, pp. 339-369, (1st runner-up under former title) of the 2010 Goldman Sachs International Prize for best European Finance Association meetings paper).

*"IQ and Stock Market Participation," (with M. Keloharju and J. Linnainmaa), 2011, *The Journal of Finance* 66 (6), pp. 2121-2164.

"Jensen's Inequality, Parameter Uncertainty, and Multi-period Investment," (with J. Linnainmaa), 2011, *Review of Asset Pricing Studies* 1 (1), pp. 1-34 (lead article and editor's choice article of inaugural issue).

**"Sensation Seeking, Overconfidence, and Trading Activity," (with M. Keloharju), 2009, *The Journal of Finance* 64 (2), pp. 549-578 (lead article).

"Debt Policy, Corporate Taxes, and Discount Rates," (with J. Liu), 2008, *Journal of Economic Theory* 141 (1), pp. 225-254.

+"Social Influence and Consumption: Evidence from the Automobile Purchases of Neighbors," (with M. Keloharju, S. Ikaheimo), 2008, *Review of Economics and Statistics* 90 (4), pp. 735-753.

**"Prospect Theory, Mental Accounting, and Momentum" (with B. Han), 2005, *Journal of Financial Economics*, 78 (2), pp. 311-339.

**"Predicting Stock Price Movements from Past Returns: The Role of Consistency and Tax-Loss Selling," (with T. Moskowitz), 2004, *Journal of Financial Economics*, 71 (3), pp. 541-579.

+"Tax-loss Trading and Wash Sales," (with M. Keloharju), 2004, *Journal of Financial Economics*, 71 (1), pp. 51-76.

"Information Aggregation, Security Design, and Currency Swaps," (with B. Chowdhry and D. Levine), 2002, *Journal of Political Economy*, 110 (3), pp. 609-633.

***"How Distance, Language, and Culture Influence Stockholdings and Trade" (with M. Keloharju), 2001, *The Journal of Finance*, 56 (3), pp. 1053-1073.

RESEARCH (continued)

ARTICLES PUBLISHED (continued)

***"What Makes Investors Trade?" (with M. Keloharju), 2001, The Journal of Finance, 56 (2), pp. 589-616.(2001 Smith-Breeden Distinguished Paper Prize), reprinted in *International Capital Markets*, René Stulz and Andrew Karolyi (eds.), Sydney, Edward Elgar Publishing, Ltd.

*"An Analytic Solution for Interest Rate Swap Spreads," 2001, *International Review of Finance*, 2 (3), pp. 113-149.

+"Financial Innovation and the Role of Derivative Securities: An Empirical Analysis of the Treasury Strips Program," (with F. Longstaff), 2000, *The Journal of Finance* 55 (3), pp. 1415-1436, published abstract, *The Journal of Finance*, (1996) 51, pp. 1043-1044.

***"The Investment Behavior and Performance of Various Investor-Types: A Study of Finland's Unique Data Set" (with M. Keloharju), 2000, *Journal of Financial Economics* 55 (1), 43-67.

"Futures vs. Forward Prices: Implications for Swap Pricing and Derivatives Valuation" (with N. Jegadeesh), 2000, in N. Jegadeesh and B. Tuckman (eds.), *Advanced Fixed-Income Valuation Tools for Professionals*, New York, Wiley, pp. 58-79.

***"Do Industries Explain Momentum?" (with T. Moskowitz), 1999, "*The Journal of Finance*," 54 (4), pp. 1249-1290.

"Stock Splits and Stock Returns for OTC Stocks: The Effects of Investor Trading and Bid-Ask Spreads on Ex-Date Returns," (with D. Keim), 1999, in Keim, D. and W. Ziemba (eds.), Security Market Imperfections in World Wide Equity Markets, Cambridge University Press, pp. 276-293.

***"Measuring Mutual Fund Performance with Characteristic-Based Benchmarks," 1997, (with K. Daniel, S. Titman, and R. Wermers)," *The Journal of Finance*, 52 (3), pp. 1035-1058, Published abstract (1997): *The Journal of Finance*, 52, pp. 1217-1218.

"The Relative Pricing of Eurodollar Futures and Forward Contracts," (with N. Jegadeesh), 1996, *The Journal of Finance*, 51 (4), .pp. 1499-1522.

***"Momentum Investment Strategies, Portfolio Performance, and Herding: A Study of Mutual Fund Behavior," (with S. Titman and R. Wermers), 1995, *American Economic Review*, 85 (5), pp. 1088-1105. Published abstract (1994): *The Journal of Finance*, 49, pp. 1069-1070.

"Performance Evaluation," (with S. Titman), 1995, in *Handbook in Operations Research and Management Science, Vol. 9: Finance*, Jarrow, R., Maksimovic, V., And Ziemba, W. (Eds.), Elsevier Science, pp. 581-609.

**"A Study of Monthly Mutual Fund Returns and Performance Evaluation Techniques," (with S. Titman), 1994, *Journal of Financial and Quantitative Analysis*, 29, pp. 419-444.

***"Performance Measurement without Benchmarks: An Examination of Mutual Fund Returns," (with S. Titman), 1993, *Journal of Business*, 66, pp. 47-68. Published extended abstract (1993): *The CFA Digest*, 23 (Spring), pp. 65-67.

RESEARCH (continued)

ARTICLES PUBLISHED (continued)

***"The Persistence of Mutual Fund Performance," (with S. Titman), 1992, *The Journal Of Finance*, 47, pp. 1977-1984.

"Performance Evaluation," 1992, in *The New Palgrave Dictionary of Money and Finance*, Newman, P., Milgate, M., and Eatwell, J. (Eds.), Stockton Press, Vol. 3 (N-Z), pp. 133-135

"How to Avoid Games Portfolio Managers Play," (with S. Titman), 1989, *Institutional Investor*, 23, 14 (Nov.), pp. 35-36.

**"Portfolio Performance Evaluation: Old Issues and New Insights," (with S. Titman), 1989, *Review of Financial Studies*, 2, pp. 393-421, reprinted in *Asset Pricing and Portfolio Performance: Models Strategy and Performance Metrics*, R. Korajczyk (ed.), London, Risk Publications, June 1999 and in *Stephen A. Ross, Mentor: Influence through Generations*, M. Grinblatt (ed.) Burr-Ridge, IL, McGraw Hill/Irwin, 2007.

*"Adverse Risk Incentives and the Design of Performance-Based Contracts," (with S. Titman), 1989, *Management Science*, 35, pp. 807-822.

***"Signalling and the Pricing of New Issues," (with C. Hwang), 1989, *Journal of Finance*, 44, pp. 393-420

***"Mutual Fund Performance: An Analysis of Quarterly Portfolio Holdings," (with S. Titman), 1989, *Journal of Business*, 62, pp. 393-416.

"How Clients Can Win the Gaming Game," (with S. Titman), 1987, *Journal of Portfolio Management*, Summer, 14-23. Reprinted in Fabozzi, Frank (ed.), 1989, *The Institutional Investor Focus on Investment Management*, pp. 239-250.

"A Put Option Paradox," (with H. Johnson), 1988, *Journal of Financial and Quantitative Analysis*, 23, pp. 23-26.

+"The Relation between Mean-Variance Efficiency and Arbitrage Pricing," (with S. Titman), 1987, *Journal of Business*, 60, pp. 97-112.

"How to Evaluate a Portfolio Manager," 1986/1987, *Financial Markets and Portfolio Management*, 1, No. 2, pp. 9-20.

"Approximate Factor Structures: Interpretations and Implications for Empirical Tests," (with S. Titman), 1985, *Journal of Finance*, 40, pp. 1367-1373.

"Market Power in a Securities Market with Endogenous Information," (with S. Ross), 1985, *Quarterly Journal of Economics*, 100, pp. 1143-1167.

**"The Valuation Effects of Stock Splits and Stock Dividends," (with R. Masulis and S. Titman), 1984, *Journal of Financial Economics*, 13, pp. 461-490.

*"Factor Pricing in a Finite Economy," (with S. Titman), 1983, *Journal of Financial Economics*, 12, pp. 497-507.

RESEARCH (continued)

BOOKS PUBLISHED

Financial Markets and Corporate Strategy: European Edition (with D. Hillier, S. Titman), Burr-Ridge, IL, McGraw-Hill/Irwin, 2009 (1st edition), 2012 (2nd edition).

Stephen A. Ross, Mentor: Influence through Generations, Burr-Ridge, IL, McGraw-Hill/Irwin, 2007.

***Financial Markets and Corporate Strategy* (with S. Titman), Burr-Ridge, IL, McGraw-Hill/Irwin, 1998 (1st edition), 2002 (2nd edition).

Solutions Manual to Accompany Financial Markets and Corporate Strategy (with S. Titman), Burr Ridge, IL, McGraw-Hill/Irwin, 1998 (1st edition), 2002 (2nd edition).

UNPUBLISHED WORKING PAPERS

"Explaining (Some) Anomalies: The Role of Analyst Bias," (with G. Jostova, A. Philipov), June 2018, submitted to the Journal of Accounting and Economics.

"Style and Skill: Hedge Funds, Mutual Funds, and Momentum," (with G. Jostova, L. Petrosek, A. Philipov), July 2018, resubmitted to Management Science.

"Global Market Inefficiencies," (with S. Bartram), July 2018, submitted to the Journal of Financial Economics.

"Psychological Perspectives on the Vulnerability of Older Adults to Fraud" (with S. Taylor, E. Castle, N. Eisenberger, T. Seeman), May 2013.

"Positive Portfolio Factors" (with S. Brown and W. Goetzmann), NBER working paper 6412, July 1997.

"The Evaluation of Mutual Fund Performance: An Analysis of Monthly Returns," (with S. Titman), March 1988.

"On the Regulation of Insider Trading," November 1987.

RESEARCH (continued)

RESEARCH IN PROGRESS

Valuation and Parameter Estimation, Tax Incentives and Social Security, Mutual Fund Benchmarks, Bitcoin Trading by Investors, Banking and Derivatives Theory, Options and Event Studies.

PAPER PRIZES

IQ-KAP Best Paper 1st Prize, "Analyst Bias and Mispricing," October 2018
Federal Association Alternative Investments Best Paper Prize, Global Market Inefficiencies, September 2018.
Acattis Value Prize, 2nd Place Prize, Global Market Inefficiencies, September 2018.
Asia Asset Management CFA Institute 2017 Best Working Paper Prize in Asset Management, Global Market Inefficiencies, September 2017.
Goldman Sachs International Prize, 1st Runner Up Best Overall Conference Paper, European Finance Association Meetings, Frankfurt, Germany, August 2010, "Do Smart Investors Outperform Dumb Investors?"
2002 Distinguished Paper Prize: Finnish Foundation for Advancement of Securities Markets, "What Makes Investors Trade."
2001 Smith-Breeden Distinguished Paper Prize: *The Journal of Finance*, January 2002, "What Makes Investors Trade?"
2000 Anbar Citation of Excellence and Highest Quality Rating: September 1996 *Journal of Finance* article, "The Relative Pricing of Eurodollar Futures and Forward Contracts."
3rd Prize: Q-group competition, 1985, "The Valuation Effects of Stock Splits and Stock Dividends."
Finalist: Berkeley Doctoral Prize Competition, 1980, "Optimal Linear Investment Strategies for a Stackelberg Leader in a Rational Expectations Model of a Speculative Market."

RESEARCH (continued)

RESEARCH FELLOWSHIPS, GRANTS, HONORS

Visiting Fellow, Yale University, May 2019.
Conference and 6-figure scholarship fund donated in honor of UCLA career, June 2018.
Visiting Fellow, Securities and Exchange Commission, April 2017.
Visiting Chair/Fellow, Hong Kong Polytech University, December 2018, June 2017, October 2016.
Visiting Summer Fellow, University of Washington, 2015.
WU Gutmann Center Research Fellow, Vienna, May 2011.
Honorary Doctorate in Economics, Aalto University, Helsinki, Finland, May 2011.
Grant, Laurence and Lori Fink Center for Finance & Investments, 2010, Jensen's Inequality, Parameter Uncertainty, and Investing
Top 5% Economics Researchers, RePEc, 2009-
Economist of the Day, February 9, 2009.
Grant: National Institute for Aging, 2009, for Social and Neural Bases of Vulnerability to Fraud in Older Adults
Grant: Inquire Europe for "Intelligence, Investment Mistakes, and Performance Heterogeneity," 2008
Grant, Laurence and Lori Fink Center for Finance & Investments, 2008, IQ and Investing
Grant: Ziman Center for Real Estate, 2007-08
Top 75 Most Prolific Authors over the first half-century of Finance, *Journal of Finance Literatur*e Winter 2005.
Grant: Harold Price Center for Entrepreneurial Studies, October 2002
One percent most cited faculty in finance, *Financial Management*. August 2001
Research Associate (elected), National Bureau of Economic Research, October 2001-2007
Bank of America Fellowship Designate, UCLA, July 2000-2005
Fellow, International Center for Finance, Yale University, June 2000-2010
Visiting Fellow, Yale University, September 1999-June 2000
Grant. Center for International Business and Economics Research, February 1998
UCLA Academic Senate Grants, 1982-87, 91-03
AGSM Research Committee Work Study Awards, 1982-87, 92-96
Grant: Geewax Terker Research Program in Financial Instruments, 1988-89
Grant: Institute for Quantitative Research in Finance, 1984
UCLA Career Development Award, 1983
Yale University Fellowship, 1977-81
Charles Hickox Fellowship, 1979-80
Phi Beta Kappa, 1978

RESEARCH (continued)

SCHOLARLY EDITORIAL SERVICE

Advisory Editor:

Journal of Financial and Quantitative Analysis 2008-
Journal of Finance 2008-2012
Journal of Economics and Business 2001-2011

Associate Editor:

Journal of Finance 2003-2008
Journal of Financial and Quantitative Analysis 1997-2008
Review of Financial Studies 1998-2001
Journal of Applied Finance 1998-2010

Reviewer:

Academic Press
Addison-Wesley Publishing
American Economic Journal: Macroeconomics
American Economic Review
Econometrica
Economics Bulletin
Economics Letters
European Physical Journal B
Financial Management
Financial Practice and Education
Global Finance Journal
Hong Kong Research Grants Council
International Economic Review
International Review of Economics and Finance
Irwin Publishing
Journal of Applied Finance
Journal of Banking and Finance
Journal of Business
Journal of Economics and Business
Journal of Economic Theory
Journal of Empirical Finance
Journal of Finance
Journal of Financial and Quantitative Analysis
Journal of Financial Economics

RESEARCH (continued)

SCHOLARLY EDITORIAL SERVICE (continued)

Journal of Financial Markets
Journal of Financial Services Research
Journal of International Money and Finance
Journal of International Financial Management and Accounting
Journal of Political Economy
Management Science
McGraw-Hill Publishing
Omega: The International Journal of Management Science
National Science Foundation Grant Proposals
Review of Derivatives Research
Review of Economic Studies
Review of Economics and Statistics
Review of Financial Studies
Tenure, Full Professor, Associate Professor, and Chair Level Promotions at Various Universities

TEACHING

TEACHING AND EDUCATOR AWARDS

Top-rated Business Creation instructor, Fall 2014, Winter 2015.
Winner, 2013 Dean's Prize for Ph.D. Student Mentorship
Winner, 2010 Citibank Teaching Award.
#1 Rated Instructor in the Core Curriculum, UCLA Anderson, Spring 2009.
Endowment Fund for Prize established by UCLA Ph.D. Alumni to honor contributions to the education of PhD students, Mark Grinblatt Prize for Excellence in Research Award, 2006.
Teacher of the Year, 1993 Fully-Employed MBA Program.

TEACHING (continued)

DOCTORAL STUDENTS SUPERVISED

Chairman:

Patrick Kiefer, UCLA, 2018, Rayliant Global Investors.
Jiasun Li, Ph.D. Finance, UCLA, 2016, George Mason University.
Kyle Matoba, Finance, UCLA, GSA Capital, London.
Michael Nowotny, Ph.D. Finance, UCLA, 2011, Boston Univ., Research Affiliates
Micah Allred, Ph.D. Finance, UCLA, 2010, Bloomberg.
Cesare Fracassi, Ph.D. Finance, UCLA, 2009, University of Texas at Austin.
Juhani Linnainmaa, Ph.D. Finance, UCLA, 2006, USC, University of Chicago.
Selale Tuzel, Ph.D. Finance, UCLA, 2005, University of Southern California.
Bing Han, Ph.D. Finance, UCLA, 2002, University of Toronto, University of Texas at Austin, and Ohio State University.
Tobias Moskowitz, Ph.D. Finance, UCLA, 1998, Yale, University of Chicago.
Mark Britten-Jones, Ph.D. Finance, UCLA, 1996, London Business School, Blackrock, and Barclay's Global Investors.
Russell Wermers, Ph.D. Finance, UCLA, 1995, University of Maryland and University of Colorado.
Chuan-Yang Hwang, Ph.D. Finance, UCLA, 1988, Nanyang Technological University Hong-Kong University of Science & Technology, and University of Pittsburgh.

Committee Member:

Shaun Davies, Ph.D. Finance, UCLA 2013, University of Colorado.
Matthias Fleckenstein, Ph.D. Finance, UCLA 2013, University of Delaware, Cornerstone Research.
Phillip Wool, Ph.D. Finance, UCLA 2013, SUNY Buffalo, Research Affiliates, LLC.
Konark Saxena, Ph.D. Finance, UCLA 2011, University of New South Wales
Yuzhao Zheng, Ph.D. Finance, UCLA, 2008, Temple University.
Tyrone Callahan, Ph.D. Finance, UCLA 1999, University of Texas at Austin, USC.
Laura Field, Ph.D. Finance, UCLA 1997, Penn State.
Taychang Wang, Ph.D. Finance, Wharton, 1988, Taiwan National University.
Pierre Hillion, Ph.D. Finance, UCLA, 1988, INSEAD.
Ross Levine, Ph.D. Economics, UCLA, 1987, UC Berkeley and Brown University.
Lorraine Glover, Ph.D. Economics, UCLA, 1987.
Maxim Engers, Ph.D. Economics, UCLA, 1984, University of Virginia.

TEACHING (continued)

CLASSROOM TEACHING

UCLA:

MBA, FEMBA, Doctoral, and Executive Education Courses

- Anderson Student Asset Management (Investment Fund Practicum)
- Foundations of Finance
- Business Creation
- Intensive Introductory Finance
- Introductory Investments
- Financial Markets and Investments
- Managerial Finance
- Theory of Finance
- Portfolio Management
- Masters in Financial Engineering Research Paper (Advisor)
- Summer Doctoral Program Research Paper (Advisor)
- Independent Study
- Field Study and Business Creation (Advisor and Technical Advisor)
- Investment Under Uncertainty
- Empirical Research in Finance
- Advanced Topics in Finance and Information Economics
- Advanced Empirical Techniques in Finance
- International Hedging
- Currency Swaps
- Finance for Non-financial Managers: Interest Rate Mathematics
- Raising Capital for Firms in the People's Republic of China

WHARTON:

MBA, Undergrad, and Executive Education Courses

- Portfolio Theory
- Performance Evaluation
- Speculative Markets
- Investment Management
- Advanced Study Project
- Independent Study

YALE:

MBA and Undergrad Teaching Assistance

- Microeconomic Theory
- Economic Analysis

ACADEMIC PROFESSIONAL ACTIVITIES

Conference Organizer:

Western Finance Association, June 2004
Southern California Finance Conference, Rancho Bernardo, CA, May 1997.
UCLA Symposium on Portfolio Performance Evaluation: March 1984.

Conference and Executive Meeting Keynote Speaker:

Journal of Corporate Finance Special Issue Conference, Hong Kong, December 2018.
Knowledge Transfer Conference, Hong Kong, December 2018.
FIRN Asset Pricing Conference, Melbourne, Australia, November 2017.
NFN Finance Workshop, Swedish House of Finance, Stockholm, Sweden May 2014
7th Conference on Professional Asset Management, Rotterdam Business School, Erasmus University, May 2014
Finance Down Under Conference, Melbourne, Australia March 2012
UCLA Japan Alumni Evening, Tokyo, Japan, September 2011
WU Gutmann Center, Vienna, Austria, May 2011.
Helsinki Finance Summit, Helsinki, Finland, May 2011.
Western Finance Association, Victoria, B.C., Canada, June 2010.
European Winter Finance Summit, Salzburg, Austria, March 2010
Board Meeting of the Ziman Center for Real Estate, May 2009.
Board Meeting of the Fink Center for Finance and Investments, February 2008.
SFM 14th Annual Conference, Kaohshing, Taiwan, December 2007

Conference Program Committee Chairman:

Western Finance Association 2004-2005

Conference Program Committee Associate Chairperson:

Western Finance Association 2011

Conference Program Committee:

American Finance Association: January 2008, 2000, 1997
Western Finance Association, 2007, 1993-2002
Utah Winter Finance Conference, 2006-2008
Jackson Hole Finance Conference, 2019, 2018, 2017, 2016, 2015, 2014, 2013
Finance Down Under Conference, 2019, 2018.
Mitsui Finance Conference, 2019
Helsinki Winter Finance Summit, 2011
Society for Financial Studies Cavalcade, 2011.
Society for Financial Studies Conference on Theoretical and Empirical Issues in Corporate Finance, 1998.
UCLA Private Equity Summit, March 2012.

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

Conference Panel Discussion Moderator/Organizer:
Finance Down Under Conference, Melbourne, Australia March 2012

Conference Special Tutorial Session:
SFM 14th Annual Conference, Kaohsiung, Taiwan December 2007

Conference Presentations of Papers:
American Finance Association: January 2015, 2013, 2010 (2 papers), 2003, 2000, 1999 (2 papers), 1997, 1996, 1994, December 1986, 1985
American Economic Association, January 2016, 2010
Western Finance Association: June 2017, 2010, 2007, 2002, 1999, 1998, 1996, 1995 (2 papers), 1994, 1987, 1983
European Finance Association: August 2011, 2010, September 1987, August 1985
The First Dolomites Winter Finance Conference, February 2019.
Jackson Hole Finance Conference, January 2012
Utah Winter Finance Conference, February 2010
Knowledge Transfer, Hong Kong Polytech December 2018.
Red Rock Conference, Springdale, Utah September 2018.
MIT Conference in honor of Stephen Ross, October 2017.
7th Symposium on Intelligent Investing, Toronto, May 2018 (sch).
Macquarie Global Quanitative Conference, Hong Kong, June 2017
Journal of Law Finance and Accounting Conference, Hong Kong, June 2017
U. Maryland Smith School UBS Conference on Asset Management in 2017: Pioneers and New Frontiers, New York, NY May 2017.
Univ. of Washington, 2nd Summer Finance Conference, August 2014
SAC Capital 4th Annual Quant Conference on Investing, November 2012
USI Conference Honoring R. Roll and E. Schwartz, Lugano, August 2011
UCLA USC UCI Joint Conference on Finance, May 2015, May 2014, May 2009
Berkeley Program in Finance, Monterey, CA, October 2002
Burridge Conference, Beaver Creek, CO, September 2000
Wharton Conference on Behavioral Finance, March 2000
Financial Management Association, Chicago, IL, October 1998
Southern California Finance Conference, Rancho Bernardo, CA, May 1997
NBER Conference on Financial Risk Assessment and Management, Boston, May 1995
5th European CEPR/ESF Financial Markets Summer Symposium, Gerzenzee, Switzerland, July 1994
UCLA Symposium on Interest Rate Derivatives: April 1994
Second International Finance Conference of the Centre HEC-ISA: July 1988
Conference on the Arbitrage Pricing Theory, USC: November 1985
Institute for Quantitative Research in Finance: May 1985
UCLA seminar for Chief Financial Officers: July 1983
Financial Management Association, October 2002, 1997

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

Conference Session Chair:

Jackson Hole Finance Conference, January 2019, 2017, 2016, 2015, 2014, 2013, 2011
American Finance Association: January 2008, 2000, 1997
Western Finance Association: June 2018, 2009, 2008, 1994
Utah Winter Finance Conference, February 2018, 2016, 2012, March 2002
University of Washington, Summer Finance Conference, July 2018
FARFE Conference, October 2017, October 2015
UBC Winter Finance Conference, March 2017

Conference Panel Discussant:

U. Maryland Smith School UBS Conference on Asset Management in 2017: Pioneers and New Frontiers, New York, NY May 2017.
MIT Conference in Memory of Stephen Ross, Cambridge, October 2018 (sch).
The State of Research in Finance, FARFE Conference, Dedham, MA, October 2011
UCLA Anderson Alumni Weekend, October 2008
Behavioral Finance Panel, FARFE Conference, Dedham, MA, October 2007

Conference Discussant:

American Finance Association: Jan. 2009, 2004, 1996, 1994, Dec. 1988, 1986, 1985
American Economic Association: January 2016, 2015.
Western Finance Association: June 1999, 1995, 1994, 1993, 1987, 1983 (2 papers)
Utah Winter Finance Conference, February 2011, 2009, 2008, 2007, 2000
Society for Financial Studies Conference on Theoretical and Empirical Issues in Corporate Finance, April 1998
UCLA Symposium on Behavioral Finance, April 1998
UCLA Symposium on Corporate Risk Management, March 1996
5th European CEPR/ESF Financial Markets Summer Symposium, July 1994
Research Conference in Financial Economics & Accounting, Rutgers, October 1990
European Finance Association: September 1987, August 1985
Econometric Society: December 1986 (2 papers)

Special Conference Participation:

FARFE Conference, Dedham, MA, October 2015, 2013, 2011, 2009
NBER Universities Research Conference, Boston, May 2007
NBER Asset Pricing, Corporate, and Behavioral Finance Meetings, April 2003, 2004
Utah Winter Finance Conference, February 2003
NBER Summer Institute, July 2002, 2005
Financial Management Association Doctoral Consortium, October 1999
UCLA, UCI, USC Annual Finance Conference, May 1998
5th European CEPR/ESF Financial Markets Summer Symposium, July 1994
1st Bridge University Conference of Business School Use of Financial Data, St. Louis, September 1992
Conference on International Capital Structure, UCLA, Fall 1991
American Iron and Steel Institute Conference, UCLA, February 1985

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

Prize Nominator and Prize Committees:

2013, 2012	Xavier Dreze Prize for Outstanding PhD Research
2011, 2007	Deutsche Bank Prize
2014, 2009-2012	Dean's Prize for PhD Mentorship
2017, 2011, 2009	Carlo Alberto Medal
2017, 2014, 2012, 2008	Onassis Prize in Trade, Shipping, and Finance
2017, 2016, 2015, 1996,	Nobel Prize in Economic Sciences

Radio and TV Interviews:

Glass-Steagall Repeal, KPCC Talk of the City, November 1999.

Invited Presentations at Scholarly Colloquia:

Arizona	September 2002
Arizona State	May 2003, April 1999
Boston College	October 1994
Calgary	March 2010
Carnegie-Mellon	February 1981
Chapman University	May 2017
Chicago	May 2008, April 2000, April 1994, March 1985, January 1981
Cincinnati	April 2018
Claremont	April 1983
Colorado	November 1994, March 2009
Columbia	Nov. 2003, Mar. 1989, Dec. 1987, May 1984
Copenhagen Business School	May 2011
Cornell	October 1999, November 1986
Dartmouth	October 2010, May 1983
DePaul/Chicago Fed Res. Bank	April 1999
Duke	April 1998, March 1987
Emory	September 2001
Erasmus University, Rotterdam	May 2011
George Washington	April 2016
Georgia State	April 2019 (scheduled)
Harvard	January 1981
Hong Kong Polytech	October 2016
Hong Kong Univ of Science & Tech	April 2011, October 2016
Houston	April 1999
Illinois, Urbana-Champaign	March 2006, April 2003
Illinois, Chicago	November 2014
Kansas State	April 1995

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

Invited Presentations at Scholarly Colloquia (continued):

Kentucky	November 2002
London Business School	May 2006
London School of Economics	May 2006
Maryland	October 2009
Massachusetts Inst. of Technology	November 1999
Michigan	October 2005, March 1985
Michigan State	November 2007
Minnesota	May 1996
Monash University, Melbourne	November 2017
Nanyang Technological University	April 2011, October 2016
National University of Singapore	April 2011
New York University	October 2007, April 2000
North Carolina	April 2011
BI Norwegian Business School	May 2011
Notre Dame	April 2000
Northwestern	December 1999, March 1985, January 1981
Oxford University	February 2014, May 2006
Penn State	November 1994, April 1994
Quantitative Investment Association and Jonathan Club of LA	March 1996
Rutgers	November 1999
Singapore Management University	April 2011, October 2016
Stanford	October 1994, May 1992, September 1983
Stockholm School of Economics	May 2014, June 1999
Swiss Institute, Lugano	August 2011
Texas at Austin	May 2012, November 2005, May 1993
Tilberg	May 2011
UBS, Sydney	October 2017
University of British Columbia	April 1996, February 1981
U.C. Berkeley	October 2003, October 1994, May 1992, February 1987, February 1981
U.C. Davis	February 1981
U.C. Irvine	April 2014, May 1996, April 1986
U.C. Los Angeles	March 2016, 2009, and 2004 November 2017, 2002, May 1999, June 1996 January 1991, July 1986, August 1984 October 1983, May 1982, February 1981
U.C. Los Angeles Fink Center	May 2013

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

Invited Presentations at Scholarly Colloquia (continued):

U.C. Riverside	April 2010, May 1995
U.C. Santa Barbara	February 1981
U.C. San Diego	April 2012
University of Hawaii	November 2018
University of Hong Kong	May 2011, October 2016
University of Melbourne	October 2017
University of New South Wales	November 2016, March 2012
University of San Diego	May 2012
Univ. of Southern California	November 2003
University of Sydney	November 2016
Vienna Grad. School of Finance	May 2011
Washington	September 2012, May 1997
Washington State	November 2000
Wharton	October 1988, March 1987, March 1981
WU Gumann Center, Vienna	May 2011
Vanderbilt	April 1995
Virginia Tech	March 2000
Yale	September 2006, March 2000, January 2000, October 1994, April 1988, October 1986, May 1983, December 1980
York	October 1986

UNIVERSITY SERVICE

2016	Ad Hoc Committee for the Appointment of David Wessels
2015-2016	Area Coordinator, Finance Ph.D. Program
2015	Chairman, Ad Hoc Committee for the Chair Appointment of Hanno Lustig
2013	Chairman, Ad Hoc Committee for the Tenured Appointment of Mikhail Chernov
2013	Ad Hoc Committee for the Adjunct Professor Promotion of Jason Hsu
2012	UCLA Anderson Hanno Lustig Term Chair Review Committee
2012	Peer Teaching Review of Paul Hibibi
2012	Advisory Board, Fink Center Private Equity Summit
2012	Chair, Task Force on the Awarding of Endowed Professorships
2011	Ad Hoc Committee for the Chair Appointment of Craig Fox
2011	Ad Hoc Committee for the Step VI promotion of Sushil Bikhchandani
2011	UCLA Anderson Term Chair Appointment Committee
2011	UCLA Anderson Management Committee
2009	UCLA Anderson Board of Visitors Meeting, Newport Beach, CA (September)

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

UNIVERSITY SERVICE (continued)

2010	Panel Discussant, An Evening with UCLA Anderson, Newport Beach (May)
2010	Panel Member, Short-Termism, Aspen Institute Event, UCLA (April)
2010	Chairman, Ad Hoc Committee for the 4th Year Review of Bruce Carlin
2008	Ad Hoc Committee for the appointment of Rene Stulz
2008	Chairman, Ad Hoc Committee for the Step VI promotion of Walter Torous
2008	Active vs. Passive Management, Session with Ric Kayne, Alumni Weekend
2008-13	Director and Dean of the UCLA Anderson Doctoral Program
2007	Teaching Evaluator of Walter Torous
2006-07	Chairman, UCLA Anderson Ph.D. Program Task Force
2006-09	UCLA Anderson School Staffing and Promotion Committee (elected)
2006	Chairman, University Ad Hoc Committee for Comm. on Academic Personnel
2005-08	Area Coordinator, Finance Ph.D. Program
2005-06	Ad Hoc Committee for the Appointment of Marcus Brunnermeier
2005	Chairman, Ad Hoc Committee for the Promotion of Jing Liu
2005	Grant Reviewer: Committee on Research of the UCLA Academic Senate
2005	Board of Visitors Presentation – Momentum and Behavioral Finance
2002-06	Proposal Development: Weston Institute for Dynamic Finance
2002	Informal Ad Hoc Committee Chairman for the Appointment of Mark Garmaise
2001	Ad Hoc Committee for the Appointment of Alan Carsrud
2001	Ad Hoc Committee for the Promotion of Shlomo Benartzi
2001-03	MBA Curriculum Committee (elected position)
2001	Finance Area Curriculum Review Committee
2001	Teaching Evaluator of Pedro Santa Clara
2001	University Ad Hoc Committee for the Committee on Academic Personnel
2000-01	Chair of Ad Hoc Committee for Appointment of Rory Knight
2000	Ad Hoc Committee for the Promotion of Olav Sorenson
2000- 2010	Faculty Liaison to Knapp Venture Competition
1998-99	Developer of Turbo Finance Curriculum Initiative in Finance
1998	AGSM Ad Hoc Committee for the Promotion of David Porter
1997-99	Fund Raising: Ctr. for Frontiers of Finance & Behavioral Finance Conference
1997	AGSM Ad Hoc Committee for the Promotion of Michael Darby
1997-99	Chairman, UCLA Finance Area
1997	AGSM Ad Hoc Committee for the Promotion of Steve Hansen
1997	Teaching Evaluator of Bhagwan Chowdhry and Pedro Santa Clara

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

UNIVERSITY SERVICE (continued)

1996-97	Chair of AGSM Doctoral Research Paper Committee
1996-97	Finance Recruiting Coordinator
1996-97	Finance Seminar Coordinator
1996	Participant in Teaching Improvement Program
1996	University Ad Hoc Committee for the Committee on Academic Personnel
1996	Chair of AGSM Ad Hoc Committee for the Promotion of A. Subrahmanyam
1994-96	AGSM Doctoral Research Paper Committee Member
1993-94	AGSM Finance Recruiting Committee
1993-99	Finance Faculty Supervisor-AGSM Student Investment Fund
1993-94	AGSM Field Study Task Force
1992-	AGSM Representative to Bridge Systems
1992-93	Teaching Evaluator of Ivo Welch
1992-93	Teaching Evaluator of Siew Hong Teoh
1992-93	Teaching Evaluator of Sushil Bikchandani
1992	Participant in HP Grant Preparation
1991-92	AGSM IT Committee and Data Subcommittee
1991-92	Ad Hoc Committee for Yoon Suh
1987	Lead Program, Finance Lecturer
1986-87	Faculty Supervisor of the program for the Provident Investment Counsel Gift
1986-87	Graduate School of Management Research Committee
1985-86	Ad Hoc Committee for the Appointment of Eduardo Schwartz
1985-87	Fund Raising for UCLA with STRS
1984-85	Graduate School of Management Doctoral Board
1984-85	Graduate School of Management Doctoral Admissions Committee
1983-87	Staff Supervisor for Finance and Business Economics Units
1983-85	Legislative Assembly Representative of Management Department
1982-83	Curriculum Revision Committee of Finance Unit

LICENSES

Registered Representative, Series 7 and NY State Blue Sky Exams, 1989-90.

ACADEMIC PROFESSIONAL ACTIVITIES (continued)

EXECUTIVE AND SPECIAL COMMITTEE POSITIONS

Directorships:

Board of Directors, *Foundation for the Advancement of Research in Financial Economics*, 2011-2017
Board of Directors, *National Bureau of Economic Research*, 2007- (UCLA representative)
Board of Directors, *American Finance Association*, 2005-2008.
Board of Directors, *Citi (formerly Salomon) Swapco, Inc.*, 1993-2015.

Officer:

President:	*Western Finance Association* 2005-2006
President Elect:	*Western Finance Association* 2004-2005
Vice-President:	*Western Finance Association* 2003-2004
Principal:	*Palisades Quant, LLC*, 2000-2001

Executive Committee:

National Bureau of Economic Research 2010-
Western Finance Association 2003-06

Nominating Committee:

American Finance Association: Editor Selection and Review Committee, 2005
American Finance Association: Vice President, Fellows, and Directors, 2003
Foundation for the Advancement of Research in Financial Economics, New Members, 2009
Society for Financial Studies: Secretary/Treasurer, February-March 2000
Western Finance Association: Officers and Directors, 2007 (chair), 2006, 2005, 2004

Audit Committee of the Board of Directors

Citi Swapco, Inc., 1993-2015

Founding Member

Foundation for the Advancement of Research in Financial Economics, 2007

Task Force Leader

American Finance Association Board of Directors, Task Force on Financial Education and Financial Literacy Initiative, 2006-2011

5 YEARS PREVIOUS TESTIMONY

Tullett Prebon PLC., et al. vs. BGC Partners, Inc., jury testimony, Superior Court of New Jersey Law Division: Hudson County, November 10-18, 2014.

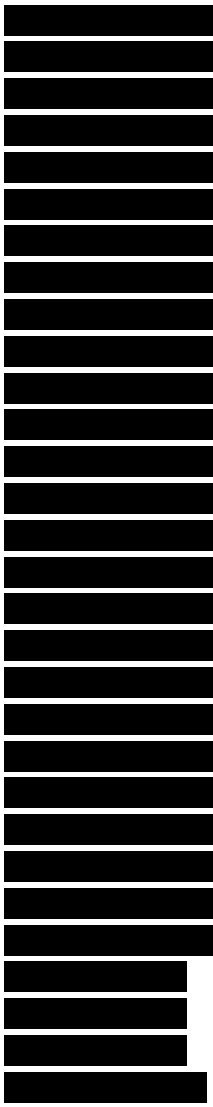
APPENDIX 2

DOCUMENTS RELIED UPON

CASE FILINGS

Class Plaintiffs' First Set of Requests for Production of Documents
Class Plaintiffs' Memorandum of Law in Support of their Motion for Class Certification
Expert Report of Darrell Duffie
Opinion and Order Granting in Part and Denying in Part Defendants' Motion to Dismiss, Dkt. 237
Order Regarding Class Plaintiffs' Motion for Clarification, Dkt. 251
Second Consolidated Amended Class Action Complaint, Dkt. 142
Third Consolidated Amended Class Action Complaint, Dkt. 398

DOCUMENTS PRODUCED IN DISCOVERY



[redacted]

DOCUMENTS PRODUCED IN DISCOVERY (NO BATES STAMP AVAILABLE)

Documents Pertaining to Data Productions

[redacted]

[redacted]

SEF Rulebooks

[redacted]

DEPOSITION TRANSCRIPTS AND EXHIBITS

[redacted]

DATA PRODUCTIONS

Defendant Transactions

[redacted]

[redacted]

Platform Transactions

[redacted]

Platform Quotes

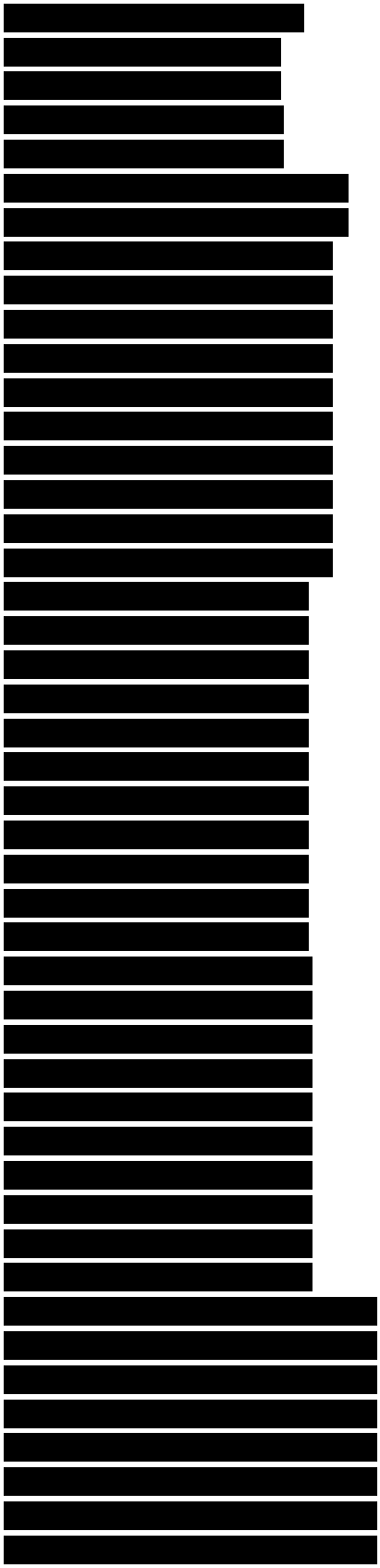
[redacted]

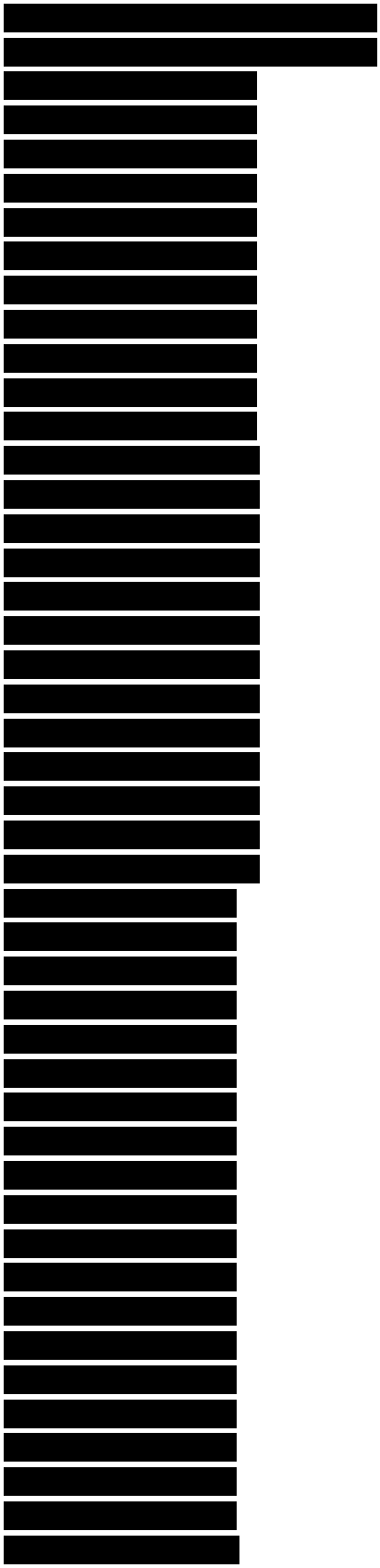
DATA PRODUCTIONS (NO BATES STAMP AVAILABLE)

Defendant Transactions

[redacted]

[redacted]





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Platform Transactions

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[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

BLOOMBERG TERMINAL

[redacted]

PUBLIC DOMAIN

Books

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Blair, Roger D. and Kaserman, David L., *Antitrust Economics,* 1st edition, 1985
Carlton, Dennis W. and Perlof, Jeffrey M., *Modern Industrial Organization,* 4th edition, 2005
Corb, Howard. *Interest Rate Swaps and Other Derivatives*, 2012
Foucault, Thierry; Pagano, Marco; and Röell, Alisa, *Market Liquidity: Theory, Evidence and Policy*, 1st edition, 2013
Grinblatt, Mark and Titman, Sheridan, *Financial Markets and Corporate Strategy,* 2nd edition, 2002
Harris, Larry, *Trading & Exchanges: Market Microstructure for Practitioners*, 2012
Nicholson, Walter, *Microeconomic Theory: Basic Principles and Extensions*, 8th edition, 2002
Sadr, Amir, *Interest Rate Swaps and Their Derivatives: A Practitioner's Guide*, Vol. 510, 2009

Academic and Research Articles

Aitken, Michael J.; Frino, Alex; Hill, Amelia M.; and Jarnecic, Elvis, "The Impact of Electronic Trading on Bid-Ask Spreads: Evidence from Futures Markets in Hong Kong, London, and Sydney," *The Journal of Futures Markets*, July 2004
Bech, Morten; Illes, Anamaria; Lewrick, Ulf; and Schrimpf, Andreas, "Hanging Up the Phone – Electronic Trading in Fixed Income Markets and its Implications," *BIS Quarterly Review*, March 2016
Benos, Evangelos; Payne, Richard; and Vasios, Michalis, "Centralized Trading, Transparency and Interest Rate Swap Market Liquidity: Evidence from the Implementation of the Dodd-Frank Act," Bank of England Staff Working Paper No. 580, 2018
Bessembinder, Hendrik; Maxwell, William; and Venkataraman, Kumar, "Market Transparency, Liquidity Externalities, and Institutional Trading Costs in Corporate Bonds," *Journal of Financial Economics*, Vol. 82, 2006
Bessembinder, Henrik and Venkataraman, Kumar, "Bid-Ask Spreads: Measuring Trade Execution Costs in Financial Markets," *Encyclopedia of Quantitative Finance*, 2010
Biais, Bruno and Declerck, Fany, "Liquidity, Competition and Price Discovery in the European Corporate Bond Market," *Toulouse School of Economics*, Working Paper, February 2013
Boehmer, Ekkehart; Saar, Gideon; and Yu, Lei, "Lifting the Veil: An Analysis of Pre-Trade Transparency at the NYSE," *The Journal of Finance*, Vol. 60, No. 2, April 2005
Broderick, Tristan and Cox, Chris, "The Foreign Exchange and Over-The-Counter Interest Rate Derivatives Markets in the United Kingdom," Bank of England, Quarterly Bulletin, 2010
Chen, Fan and Zhong, Zhuo, "Pre-trade Transparency in Over-the-Counter Markets," Working Paper, August 2012
Chung, Kee H. and Chuwonganant, Chairat, "Transparency and Market Quality: Evidence from SuperMontage," *Journal of Financial Intermediation*, Vol. 18, 2009
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Duffie, Darrell; Gârleanu, Nicolae; and Pedersen, Lasse Heje, "Over-the-Counter Markets," *Econometrica*, Vol. 73, No. 6, November 2005

Edwards, Amy K.; Harris, Lawrence E.; and Piwowar, Michael S., "Corporate Bond Market Transaction Costs and Transparency," *The Journal of Finance*, Vol. 62, No. 3, June 2007

Eom, Kyong Shik; Ok, Jinho; and Park, Jong-Ho, "Pre-Trade Transparency and Market Quality," *Journal of Financial Markets*, 2007

Fink, Jason; Fink, Kristin E.; and Weston, James P., "Competition on the Nasdaq and the Growth of Electronic Communication Networks," *Journal of Banking & Finance*, Vol. 30, 2006

Finnerty, Joseph E., "The Chicago Board Options Exchange and Market Efficiency", *Journal of Financial and Qualitative Analysis,* March 1978

Fleming, Michael J.; Mizrach, Bruce; and Nguyen, Giang, "The Microstructure of a U.S. Treasury ECN: The BrokerTec Platform," Federal Reserve Bank of New York, Staff Report No. 381, July 2009; Revised March 2017

Fleming, Michael; Jackson, John; Li, Ada; Sarkar, Asani; and Zobel, Patricia, "An Analysis of OTC Interest Rate Derivatives Transactions: Implications for Public Reporting," Federal Reserve Bank of New York Staff Reports, Staff Report No. 557, October 2012

Flood, Mark D.; Huisman, Ronal; Koedijk, Kees G.; and Mahieu, Ronald J., "Quote Disclosure and Price Discovery in Multiple-Dealer Financial Markets," *The Review of Financial Studies*, Vol. 12, No. 1, 1999

Foucault, Thierry; Moinas, Sophie; and Theissen, Erik, "Does Anonymity Matter in Electronic Limit Order Markets?" *The Review of Financial Studies*, Vol. 20, No. 5, 2007

Frino, Alex; McInish, Thomas H.; and Toner, Martin, "The Liquidity of Automated Exchanges: New Evidence from German Bund Futures," *Journal of International Financial Markets Institutions and Money*, Vol. 8, 1998

Goldstein, Michael A.; Hotchkiss, Edith S.; and Sirri, Erik R., "Transparency and Liquidity: A Controlled Experiment on Corporate Bonds," Published by Oxford University Press on behalf of The Society for Financial Studies, Advance Access publication July 1, 2006

Harris, Lawrence E. and Piwowar, Michael, "Secondary Trading Costs in the Municipal Bond Market," *Journal of Finance*, Vol. 61, No. 3, 2006

Hendershott, Terrence and Jones, Charles M., "Island Goes Dark: Transparency, Fragmentation, and Regulation." *The Review of Financial Studies*, Vol. 18, No. 3, 2005

Hendershott, Terrence and Madhavan, Ananth, "Click or Call? Auction Versus Search in the Over-the-Counter Markets." *The Journal of Finance*, Vol. 70, No. 1, February 2015

Huang, Roger D. and Masulis, Ronald W., "FX Spreads and Dealer Competition across the 24-Hour Trading Day," *The Review of Financial Studies*, Vol. 12, No. 1, Spring 1999

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Kuprianov, Anatoli, "Over-the-Counter Interest Rate Derivatives," Federal Reserve Bank of Richmond, *Economic Quarterly*, Vol. 9, 1993

Li, Chun-An and Lai, Hung-Cheng, "The Impact of the Trading Systems Development on Bid-Ask Spreads," *Investment Management and Financial Innovations*, Vol. 5, Issue 1, 2008

McAndrews, James and Stefanadis, Chris, "The Emergence of Electronic Communications Networks in the U.S. Equity Markets," Federal Reserve Bank of New York, *Current Issues in Economics and Finance*, Vol. 6, No. 12, October 2000

Mizrach, Bruce and Neely, Christopher J., "The Transition to Electronic Communications Networks in the Secondary Treasury Market," Federal Reserve Bank of St. Louis, *Review*, 2006

Mulherin, J. Harold; Netter, Jeffrey M.; and Overdahl, James A., "Prices are Property: The Organization of Financial Exchanges from a Transaction Cost Perspective," *The Journal of Law & Economics*, Vol. 34, No. 2, 1991

Osler, Carol; Bjonnes, Geir; and Kathitziotis, Neophytos, "Bid-Ask Spreads in OTC Markets," Working Paper Series, Brandeis University, 2016

Pirrong, Craig, "Market Liquidity and Depth on Computerized and Open Outcry Trading Systems: A Compression of DTB and LIFFE Bund Contracts," *The Journal of Futures Markets*, Vol. 16, No. 5, August 1996

Pirrong, Craig, "The Economics of Central Clearing: Theory and Practice," ISDA Discussion Paper Series No. 1, 2011

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Remolona, Eli M. and Wooldridge, Philip D., "The Euro Interest Rate Swap Market," Bank for International Settlements, *Quarterly Review*, March 2003

Roll, Richard, "A Simple Implicit Measure of the Effective Bid-Ask Spread in an Efficient Market," *The Journal of Finance*, Vol. 39, No. 4, September 1984

Romer, Paul, "Endogenous Technological Change," *Journal of Political Economy*, Vol. 98, No. 5, Pt. 2, 1990

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Scholes, Myron S., "Derivatives in a Dynamic Environment," Nobel Lecture in *Economic Sciences*, 1997

Telser, Lester G., "Why There Are Organized Futures Markets," *Journal of Law and Economics*, 1981

The Historical Society of Pennsylvania, Collection 3070: Philadelphia Stock Exchange Papers, 2006

Thompson, Sarahelen R. and Waller, Mark L., "The Execution Cost of Trading in Commodity Futures Markets," *Food Research Institute Studies*, Vol. 20, No. 2, 1987

Thompson, Sarahelen R. and Waller, Mark L., "Determination of Liquidity Costs in Commodity Futures Markets," *The Review of Futures Markets*, Vol. 7, No. 1, 1988

Zhao, Xin and Chung, Kee H., "Information Disclosure and Market Quality: The Effect of SEC Rule 605 on Trading Costs," *Journal of Financial and Quantitative Analysis*, Vol. 42, No. 3, September 2007

Regulatory and Industry Literature

2000 ISDA Definitions

2002 ISDA Master Agreement

2006 ISDA Definitions

CFTC 17 CFR Part 43, Real-Time Public Reporting of Swap Transaction Data, January 9, 2012

CFTC 17 CFR Parts 39 and 50, Clearing Requirement Determination under Section 2(h) of the CEA; Final Rule § 50.2 (2012)

CFTC No Action Letter No. 14-12 (February 10, 2014)

CFTC No Action Letter No. 15-55 (October 14, 2015)

CFTC No Action Letter No. 16-76 (November 1, 2016)
Committee on Payment and Settlement Systems, "New Developments in Clearing and Settlement Arrangements for OTC Derivatives," *Bank for International Settlements* (March 2007)
Litan, Robert, "Futurization of Swaps: A Clever Innovation Raises Novel Policy Issues for Regulators," *Bloomberg Government* (January 14, 2013)
Markets Committee, "Electronic Trading in Fixed Income Markets," *Bank for International Settlements* (January 2016)
U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, and U.S. Commodity Futures Trading Commission, "Joint Staff Report: The U.S. Treasury Market on October 15, 2014," (July 13, 2015)
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Abouhossein, Kian; Lee, Delphine; and Leech, Cormac, "Regulatory Proposal Analysis: Structural IB Profitability Decline," JPMorgan, September 9, 2009
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CFTC, *CFTC Announces that Mandatory Clearing Begins Today*, Release Number 6529-13 (2013), https://www.cftc.gov/PressRoom/PressReleases/pr6529-13
CFTC, *Data Repositories*, https://www.cftc.gov/IndustryOversight/DataRepositories/index.htm
CFTC, *Real-Time Reporting*, https://www.cftc.gov/LawRegulation/DoddFrankAct/Rulemakings/DF_18_RealTimeReporting/index.htm
CFTC, *Swaps Made Available to Trade*, http://cftc.gov/PressRoom/PressReleases/ssLINK/swapsmadeavailablechart
Chicago Board Options Exchange (CBOE), *CBOE History*, http://www.cboe.com/aboutcboe/history
Clarus Financial Technology (ClarusFT), *2015 SEF Market Share Statistics*, https://www.clarusft.com/2015-sef-market-share-statistics/
Clarus Financial Technology (ClarusFT), *2016 SEF Market Share Statistics*, https://www.clarusft.com/2016-sef-market-share-statistics/

Clarus Financial Technology (ClarusFT), *CME-LCH Basis Spread*, https://www.clarusft.com/cme-lch-basis-spreads/

Clarus Financial Technology (ClarusFT), Compression in Swaps, https://www.clarusft.com/compression-in-swaps/

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ICE Benchmark Administration, *Roadmap for ICE LIBOR*, https://www.theice.com/publicdocs/ICE_LIBOR_Roadmap0316.pdf

Intercontinental Exchange (ICE), *ICE Futures U.S. to Complete Transition to Electronic Trading* (2012), https://ir.theice.com/press/press-releases/all-categories/2012/07-26-2012

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APPENDIX 3
DATA PRODUCED BY DEFENDANTS AND THIRD PARTIES
TRANSACTION AND QUOTE DATA

1. This appendix describes the data made available to me as of the date of my report. I include a table that summarizes the data at the end of this appendix.

2. ***Quote Data.*** [redacted]

3. Bloomberg is a widely used third-party vendor of IRS quote data relied on by investors, dealers, regulators and academics to make trade decisions, conduct research studies, and learn about the IRS market. Bloomberg provides current and historical quotes for a wide range of standardized IRS, including swaps within each of the four product categories in the class. [redacted]

4. Bloomberg describes its data sources as contributing dealer banks with "[redacted]" quotes.[249] While Bloomberg omits the names of contributing dealers, its documentation states that the quotes are [redacted][251]

[248] In Section V, I describe my basis for incorporating the quote data into my model.

[249] Current quotes are described by Bloomberg as quotes that can be no more than thirty seconds old. *See* "[redacted] downloaded from the Bloomberg terminal on November 1, 2018.

[250] Bloomberg announced that its "ALLQ Derivatives" platform began reporting "indicative prices" for OTC swaps in 2011. *See* Bloomberg, *Bloomberg launches trading platform for derivatives compliance*, (September 22, 2011), https://www.bloomberg.com/company/announcements/bloomberg-launches-trading-platform-for-derivatives-compliance-2/.

[251] Bloomberg announced that its ALLQ platform included as participants Dealer Defendant banks [redacted], and [redacted] *See id.*

5. Bloomberg's historical quotes are "composite" aggregations of contributing dealers' indicative quotes. The Bloomberg CMPN composite is a "best market" calculation defined as the best prevailing bid quote and best prevailing ask quote at a point in time.[252] The composite best bid equals the highest quoted bid rate of contributing dealers, and the composite best ask equals the lowest quoted ask rate of contributing dealers. The CMPN composite quote data does not include any information about trade size.

6. Bloomberg CMPN quotes are available for many IRS instruments—including fixed-floating, OIS, basis swaps, and FRAs—of various tenors, currencies, reference indexes and payment schedules. Based on these features, Bloomberg assigns security tickers to that instrument.[253] The SEF transaction data used in my analysis (and described below) has fields that identify the attributes of each IRS. From these attributes, I am able to identify the corresponding Bloomberg tickers. Appendix 4 provides a further discussion of the procedures I performed to match Bloomberg quotes to SEF data.

7. Another source of quote data was received from the Tradeweb SEF. [redacted]

8. I also received quote data from trueEX and TeraExchange. [redacted]

[252] CMPN stands for "Bloomberg New York Composite." The CMPN composite is recalculated immediately upon the arrival of new quotes from valid contributing dealers. Bloomberg has two other composite quote series, BGN and CBBT, but the CMPN composite quotes cover a wider range of IRS instruments and are available over a longer historical time period than BGN and CBBT.

[253] For example, the security ticker USSW5 is an IRS swap with the following attributes: five-year tenor; spot-starting, fixed-floating USD denominated swap where the floating reference index is three-month U.S. dollar LIBOR and the position is outright, *i.e.*, non-packaged. A USSW5 ticker is further defined as having the following payment structures: floating payments at three-month intervals on an ACT/360 basis, and fixed rate payments at semiannual intervals on a 30/360 basis.

[redacted][254]

9. Four IDBs produced quote data: [redacted] and [redacted] Quote data was requested from [redacted] has not been produced at the time of this report. [redacted] and [redacted] produced continuous quote data series, *i.e.*, time-stamped intraday quotes for the class period, but there were limitations in my ability to use this information. For example, because the [redacted] quote data did not contain important information about the attributes of the swap, the quote could not be matched to a specific swap executed by the class. The [redacted] quote does not contain product description to verify the type of swap product and it does not specify other critical attributes such as the reference index, whether the contract is spot or forward starting, or a day count convention.

10. I have also been unable to reliably utilize the [redacted] quote data since it appears to include only quote data for basis swaps. Questions to [redacted] about the attributes of the quotes were not answered as of the date of this report and are impeding my ability to rely on the information.

11. Quote data produced by [redacted] and [redacted] are limited to 19 days and 21 days respectively over the class period. Both datasets have enigmatic variations in their quote volume per day. [redacted] quotes range from about [redacted] to [redacted] per day. The [redacted] quotes varied between [redacted] and [redacted] per day. By way of comparison, the distribution of [redacted] quotes show relative consistency in quote volume over the class period. For example, the number of quotes from 2013-2016 ranges from ten thousand to [redacted] quotes per day for most USD and Euro denominated spot-starting traditional fixed-floating swaps.

12. As discussed in my report, [redacted]

13. ***Transaction Data.*** IRS transactions between class members and Defendants have been recorded in databases by various entities, including the Defendants' platforms, IDB SEFs, buy-side SEFs, and entities such as clearing houses and the [redacted] The datasets from these various entities record and organize transaction information differently because each provides a view of market activity as determined by the entity's purpose. For example, transaction data from

[254] According to ClarusFT, trueEX accounted for less than five percent of SEF IRS trades from 2014-2016. *See* Clarus Financial Technology (ClarusFT), *2015 and 2016 SEF Market Share Statistics*, https://www.clarusft.com/2015-sef-market-share-statistics/, https://www.clarusft.com/2016-sef-market-share-statistics/. ClarusFT did not report a separate share estimate for Tera Exchange for 2015 or 2016.

the SEFs record trades executed on their platforms only. Since SEF platforms like Bloomberg and Tradeweb are dedicated to facilitating trades between dealers and buy-side customers, the transactional records from these two entities provide a robust dataset for D2C trades executed on a SEF.

14. My methodology requires accurate information about certain elements of a trade. This includes information about: the execution date and time; the transaction price, *i.e.*, a rate or spread to determine the periodic payments by the counterparties; the contract's economic attributes such as currency, tenor, floating rate reference index, start or effective date, and the notional amount; the identities of the counterparties; trade direction fields; whether the trade was part of a package, and; whether the record represented the opening of a new position or "new trade" or actions undertaken for termination, novation, compression or other non-pricing forming activity, *e.g.*, cancellations.

15. As I discuss below, the Defendants and third parties differed in their ability to provide this critical information. Accordingly, I considered the attributes of each data source and ultimately incorporated three sources of data into my model: (1) Bloomberg SEF; (2) Tradeweb, and; (3) Part 43 data.

16. ***SDRs:*** One source of transaction information came from the DTCC and Bloomberg SDRs. Swaps are reported to the SDRs in accordance with rules established by the CFTC. The DTCC SDR is the larger of the two based on the number of IRS transactions reported annually. As touched upon previously, there are two types of data reported to SDRs: Part 43 and Part 45.

17. Part 43 data is publicly available, timestamped information about each transacted swap.[255] For transactions executed during the class period, the Part 43 transactions were obtained from Bloomberg which keeps historical records of the transactions reported to the DTCC and Bloomberg SDRs. As previously discussed, the Part 43 real-time reporting requirements pertain to any executed swap that is an arm's length transaction between two parties and results in a corresponding change in the market risk position between the two parties.[256] Transactions that do not enhance price discovery are not required to be reported to a SDR, such as portfolio compression

[255] The publicly available Part 43 SDR data was retrieved from a Bloomberg terminal using the "SDR Trade Activity" screen.

[256] *See* 17 CFR Part 43, § 2.

exercises or internal transactions to move risk between wholly-owned subsidiaries of the same parent.

18. I relied upon the Part 43 data despite certain limitations. For example, counterparties to each transaction are not publicly disclosed. That means that one cannot distinguish between a D2D or D2C transaction. The Part 43 data identifies trades conducted on a SEF platform, but does not identify the name of the SEF. Since the execution protocols differ across SEFs, not knowing the identity of the SEF constrains the ability to understand how trades were negotiated and executed, for example, as an RFQ, CLOB or electronic versus non-electronic protocol, *i.e.*, voice. The Part 43 data also does not always report the exact notional amount for a given transaction. Notional amounts on large transactions can be reported at their lower block thresholds or rounded according to CFTC rules.[257]

19. The DTCC Part 45 data contains comprehensive information about each IRS transaction, both "swap creation data" and "swap continuation data." I received the Part 45 data from the DTCC in two productions, first on October 17, 2018 and later on October 31, 2018. The DTCC production includes over [redacted] that average about [redacted] each and total over [redacted] of data.

20. Swap creation data includes the primary economic terms ("PET") for any swap that has been matched or affirmed by the counterparties. In addition to most of the Part 43 data fields, the Part 45 PET data includes hundreds of additional fields for each swap. The swap continuation data includes any changes to the previous days' reported data for a swap, including lifecycle events such as amortization of principal, changes in the rate on reset dates, and changes in the valuation of a swap.

21. The Part 45 data is limited to end-of-day snapshot data, meaning the information recorded for a swap represented an accumulation of trade activity on a given day. In addition, the production included a mix of "alpha" records, which reflected information pertaining to the original bilateral transaction, along with its execution timestamp, as well as "beta" and "gamma" records, which reflected the central clearing party record with no execution timestamp. For a given IRS, the DTCC provided variants of this information for a particular swap: an alpha record; an alpha record with its corresponding beta and/or gamma record; a beta and gamma record only; a

[257] *See* 17 CFR §43.4(g) (2012).

beta record only; or a gamma record only. This meant the production included extensive duplications of swap records and different specifications of a swap's attributes depending on whether the alpha, beta or gamma records were analyzed. My review of the DTCC Part 45 data continues; it is my expectation to ultimately incorporate transactions from this dataset into my model.

22. ***SEFs and IDBs:*** The two largest buy-side platforms, Bloomberg SEF and Tradeweb, produced their transaction data with reliable execution time stamps (to the second), counterparty information, and each of the key fields reflecting the economic terms of the transactions. I also received data from two other buy-side platforms. The trueEX data included only about [redacted] transactions, nearly all of which were portfolio compression trades. The Javelin data was not utilized in my report, but I continue to analyze it and expect to incorporate it if proves feasible to do so.

23. I also received transaction data from six IDB platforms: BGC, Dealerweb, GFI, ICAP, Tullet Prebon, and Tradition.[258] None of the IDB productions contained information about the trade direction, meaning I could not tell which of the two counterparties to the trade initiated the transaction and was respectively the liquidity seeker (versus liquidity maker).

24. The Dealerweb data did not contain an important variable indicating whether a transaction was executed on- or off-SEF. The transaction data produced by the GFI SEF appeared incomplete as it contained only about [redacted] transactions with unique record identifiers[259] and also contained a field indicating that all of the transactions had not been executed.[260] Transaction data produced by ICAP did not contain a time stamp.[261] Data produced by Tullet Prebon (specifically TPAC) was unreliable as evidenced by the many records populated with descriptors such as

[258] *See* Appendix 2 list of transactions data productions for BGC, Dealerweb, ICAP, Tradition, tpSEF and TPAC.

[259] It is my understanding that a transaction ID in the GFI data is used to identify a unique trade. The [redacted] data contained about [redacted] trade records but only [redacted] contained unique transaction IDs. *See* document provided by counsel: [redacted]

[260] The GFI transactions data field "Was Trans Executed" was populated with a value of "[redacted]" on all [redacted] records.

[261] The only field in ICAP recording when a trade was executed was "[redacted] which [redacted]

"rebates", "null" or a blank field.[262] The data specific to tpSEF did not indicate important attributes of the contract such as the reference index. Lastly, data provided by Tradition only contained records produced between the Defendants and counterparties, rather than all transactions executed on the platform.[263]

25. ***Defendants:*** The Defendants produced millions of transaction records which differed in significant ways and thus influenced the construction of my economic model. For the most part, I determined these data were unusable.

26. *First*, five of the Defendants produced transaction data with no execution time stamps because they claimed they did not possess this information.[264,] Another defendant, [redacted], provided execution time stamps but only for about [redacted]% of its transactions. [redacted] did not provide execution time stamps to the second, only to minute increments.

27. *Second*, many of the dealers heavily redacted the counterparty names on each record, and as a result, in every production, I was unable to reliably and independently distinguish a D2D from a D2C transaction. For example, [redacted] redacted [redacted]% of its counterparty fields. [redacted] redacted over [redacted]% of the counterparty fields for their fixed-floating and FRA products. [redacted]% of the counterparty fields in the [redacted] production were redacted or unavailable. In other data sets, the Defendants provided a code or numeric value in the counterparty field but did not provide a lookup table that would have enabled me to discern the name of the specific entity and independently conclude whether the counterparties were a dealer or customer. For example, [redacted] and [redacted] redacted [redacted]%, [redacted]% and [redacted]% respectively of their counterparty fields.

28. *Third*, in some instances when counterparty names are provided, it is not possible to separate price forming transactions from non-price forming transactions such as transactions reflecting the "internal" transfer of a position from one defendant entity to another defendant-affiliated entity. For example, about [redacted]% of [redacted] records are identified as transactions occurring between two [redacted] entities.

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[262] The [redacted] data file [redacted] contained [redacted] rows with the value "[redacted]"

[263] Tradition produced eleven separate spreadsheets, each corresponding to a Defendant. On each spreadsheet, the Defendant's name is repeated on every record in the data field "Firm" indicating [redacted] data production does not include all trades on its platform but instead only trades where a Defendant was a counterparty.

[264] The Defendants include [redacted]

29. *Fourth*, the records produced by some Defendants did not reflect the original bilateral trade, but rather the clearing record between the defendant and clearing firm. For example, about [redacted]% of [redacted] transactions are identified as occurring between a [redacted] entity and either [redacted] or [redacted] and no additional information is provided that identifies the ultimate counterparty. This is also true for about [redacted]% of [redacted]'s records.

30. *Lastly*, some Defendants did not provide sufficient information about the economic attributes of the transactions. For example, I could not discern the direction of a trade from certain dealer productions or determine whether a swap was part of a package trade or a stand-alone transaction. For example, I could not discern the direction of a trade (as it pertains to which party is paying or receiving the fixed rate) in [redacted] or [redacted] productions. For the productions of [redacted] and [redacted] I could not determine whether a swap was part of a package trade or a stand-alone transaction.

31. As a result of the widespread issues in Defendants' data productions, I determined that the dealers' productions collectively provided insufficient information and could not be incorporated into my model.

32. ***Clearing firms*:** The [redacted] and [redacted] are the two primary firms that clear IRS transactions. The larger of the two, [redacted], only recently produced transaction data reflecting its clearing records for IRS in over [redacted] files containing multiple record messages. Unfortunately, because I did not receive this information until December 20, 2018, I was unable to reliably incorporate this information into my current analysis. From my initial review of the data, it appears that it could also be a useful source of information in future.

TABLE 3.1

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]									
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

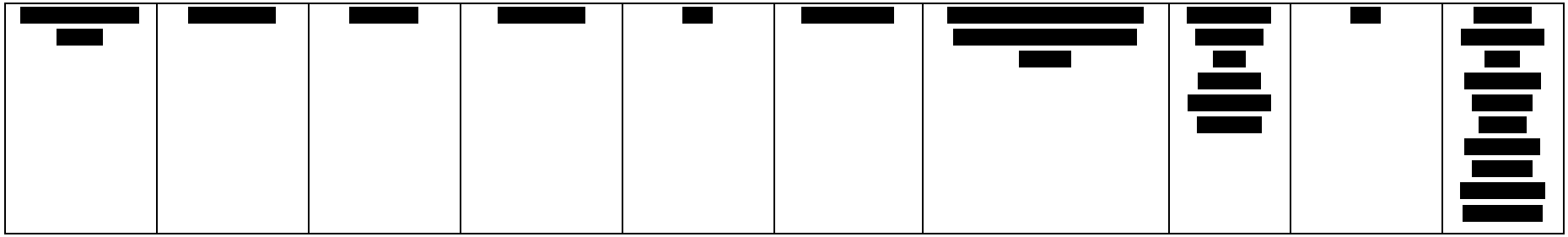


TABLE 3.2
QUOTE DATA

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]								
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

APPENDIX 4
METHODOLOGY FOR MATCHING BLOOMBERG QUOTES TO SEF-PLATFORM TRANSACTIONS

1. The economic model relies on accurate matching of buy-side swap transactions to Bloomberg quotes on those transactions. This step in my analysis is complicated by the fact that the SEF transaction data does not incorporate a Bloomberg ticker field which would have allowed me to directly match a swap transaction to its respective Bloomberg quotes. This Appendix describes the methodology I followed to address this structural data issue, specifically, how I match Bloomberg quote data, which is organized by unique Bloomberg tickers, to corresponding SEF platform transactions.

2. By way of background, the Bloomberg architecture provides a means to systematically search for IRS contracts individually, by groups or in combinations, *i.e.* packages, find their corresponding Bloomberg ticker and observe quotes for the ticker at any point in time over the class period. Bloomberg tickers are alpha-numeric codes corresponding to interest rate swap contracts with specific attributes. Within its IRS product category, the functionality of the Bloomberg terminal allows the user to filter on select IRS instruments by economic attributes such as its currency, reference index, or tenor and identify the unique ticker that Bloomberg assigns to a swap with the attributes selected. Once this ticker is known, additional information about the ticker and its contract attributes can be obtained from other screens on the terminal. The Bloomberg tickers also distinguish between an outright swap position and packaged positions such as curves or butterflies. In other words, there are specific tickers that pertain to packaged swaps.

3. It is the unique economic attributes of a swap contract that define its corresponding Bloomberg ticker and, it follows, the means to match Bloomberg tickers to swaps transactions data that I incorporate into my analysis.

4. [redacted]

[redacted][265] As described below, the attributes I use for hand matching capture the swap's attributes that were made available in the SEF transaction production which capture nearly all of the important attributes of the four product categories within the class definition. If in some instances the trade data did not record an important attribute, I adjusted my matching as explained below.

5. ***Spot-starting Fixed-Floating Contracts*:** Table 4.1 below lists [redacted] This table shows that [redacted]

Table 4.1

[redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

6. [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

[265] *See* [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

7. The field "[redacted] would be blank and the value of [redacted]" would be [redacted] since [redacted]

8. The contract tenor in this example is [redacted]

9. If the same swap was reported in the Tradeweb data, the following criteria would be applied to the Tradeweb SEF data fields listed in Table [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

10. The date information in the fields "[redacted] "[redacted] and "[redacted] are used [redacted]

11. [redacted] is shown in the table below.

Table 4.2

[redacted]

12. Note that the ticker description [redacted]

13. Note also that the ticker description for this swap [redacted]

14. ***Forward-starting Fixed-Floating Contracts*:** [redacted]

15. [redacted] reflected in Table 4.2. [redacted] the attributes in Table 4.2

16. For example, [redacted] The Bloomberg ticker description is "[redacted] is shown in the following table.

Table 4.3

[redacted]

17. ***Packaged Fixed-Floating Contracts*:** My review of the Tradeweb and Bloomberg SEF platform data indicates [redacted] In the Tradeweb SEF data, [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted] In the Bloomberg SEF data, [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

18. [redacted]

[redacted]

Table 4.4

[redacted]

[redacted]

19. ***Overnight Index Swap Contracts*:** [redacted]

[redacted]

20. Using the Bloomberg SEF data, a [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

21. [redacted]

22. As an example [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

23. The documentation accompanying Tradeweb's data production explains [redacted]

24. [redacted]

25. [redacted]

[266] *See* [redacted] at p. 2.

[267] *See* [redacted], p. 70.

[redacted]

Table 4.5

[redacted]

26. ***Spot-starting Basis Swaps*:** [redacted]

27. Using the Bloomberg SEF data, [redacted] listed in Table 4.1:

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

28. Note that the Bloomberg SEF data set [redacted]

[redacted]

29. For the Tradeweb SEF data, [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

30. [redacted]

31. [redacted]

Table 4.6

[redacted]

APPENDIX 5
THE STATISTICAL MODELING OF EFFECTIVE SPREADS

32. This Appendix describes the statistical models I develop and implement in order to compute the effective spreads incurred by buyside investors in IRS transactions during the class period.

MODELS OF EFFECTIVE SPREADS FOR OUTRIGHT FIXED-FLOAT IRS TRANSACTIONS USING QUOTE DATA

DATA USED IN THE ANALYSIS

33. As a first step in this analysis, [redacted]

34. [redacted]

35. [redacted]

36. [redacted]

[redacted]

Figure 5.1.

[redacted]

37. The chart shows [redacted]

[redacted]

[268] [redacted]

Figure 5.2A

Figure 5.2B

38.

39.

40. [redacted]

41. [redacted]

Figure 5.3.

42.

43.

[269]

[269]

[redacted]

44. [redacted]

45. [redacted]

46. Following well-established principles in the research on market microstructure, [redacted] can be expressed as:

[redacted] (1)

where the "[redacted]" = [redacted].

Under this model, [redacted]

47. [redacted]

[redacted] (2)

where the term '[redacted]' represents [redacted]) and [redacted] ([redacted]).

48. [redacted][270]

[270] [redacted]

[redacted]

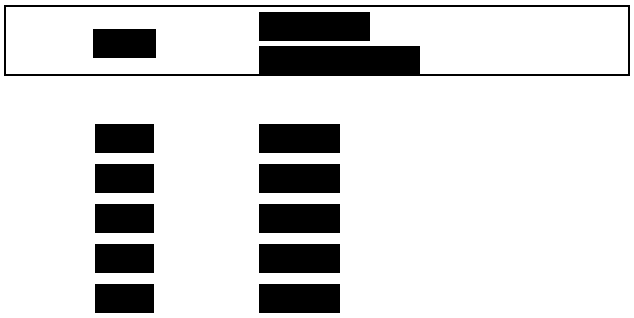
49. [redacted][271]

50. [redacted]

[271] [redacted]

Table 5.1

[redacted]



51. [redacted]

52. In the models presented [redacted], I estimate the [redacted]

53. [redacted]

54. [redacted]

272 [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

55. [redacted]

56. This model can be formally described as:

(5)

[redacted]

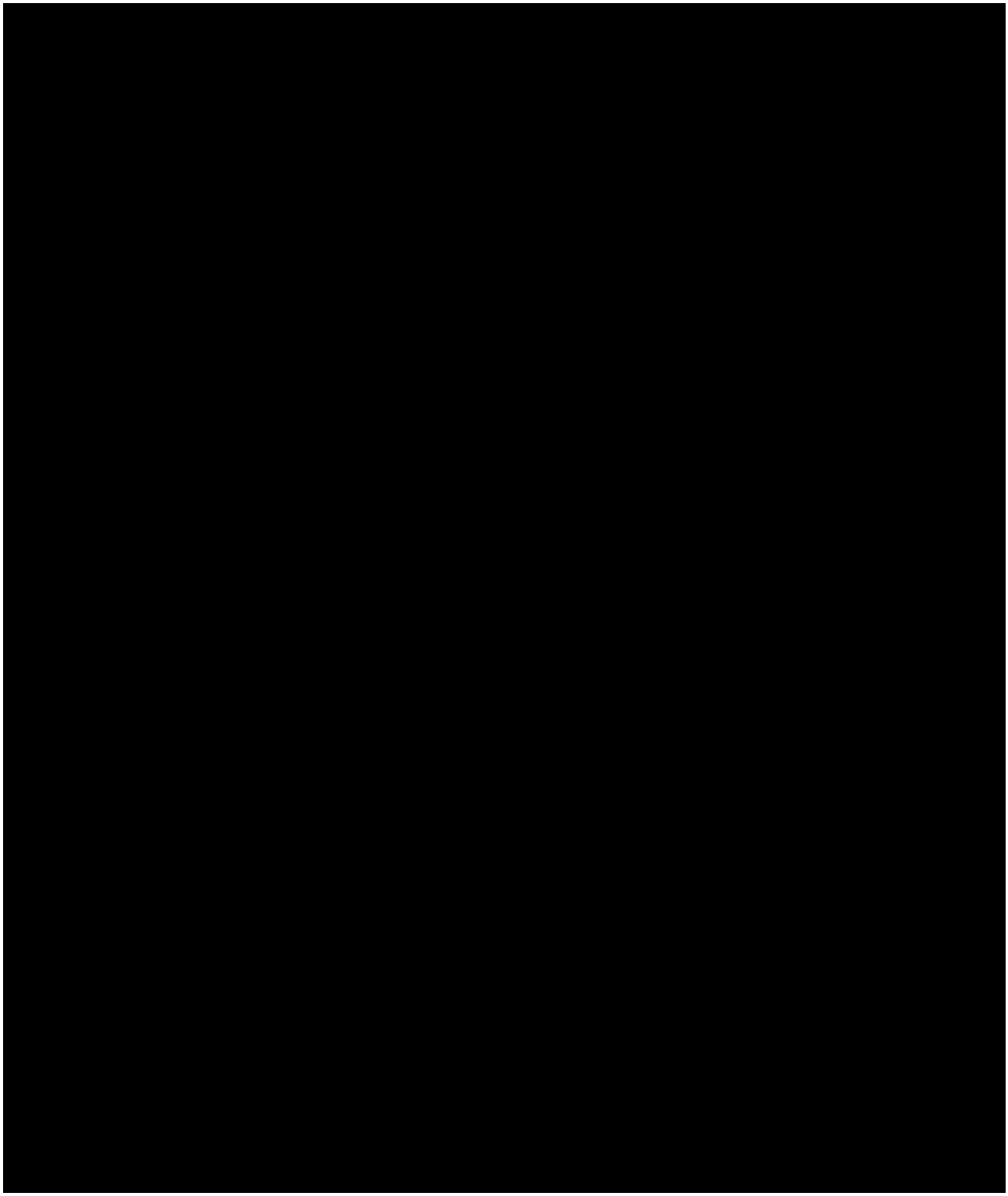
$t=1$

[redacted]

57. [redacted]

Table 5.2

[redacted]



MODELS OF EFFECTIVE SPREADS FOR OUTRIGHT FIXED-FLOAT IRS TRANSACTIONS USING PRICE-BASED DATA

58. [redacted]

59. [redacted]

60. Table 5.3 contains [redacted]

Table 5.3

[redacted]

[273] Thompson, Sarahelen R., and Mark L. Waller. "The execution cost of trading in commodity futures markets." *Food Research Institute Studies* 20.1387-2016-116196 (1987): 141.